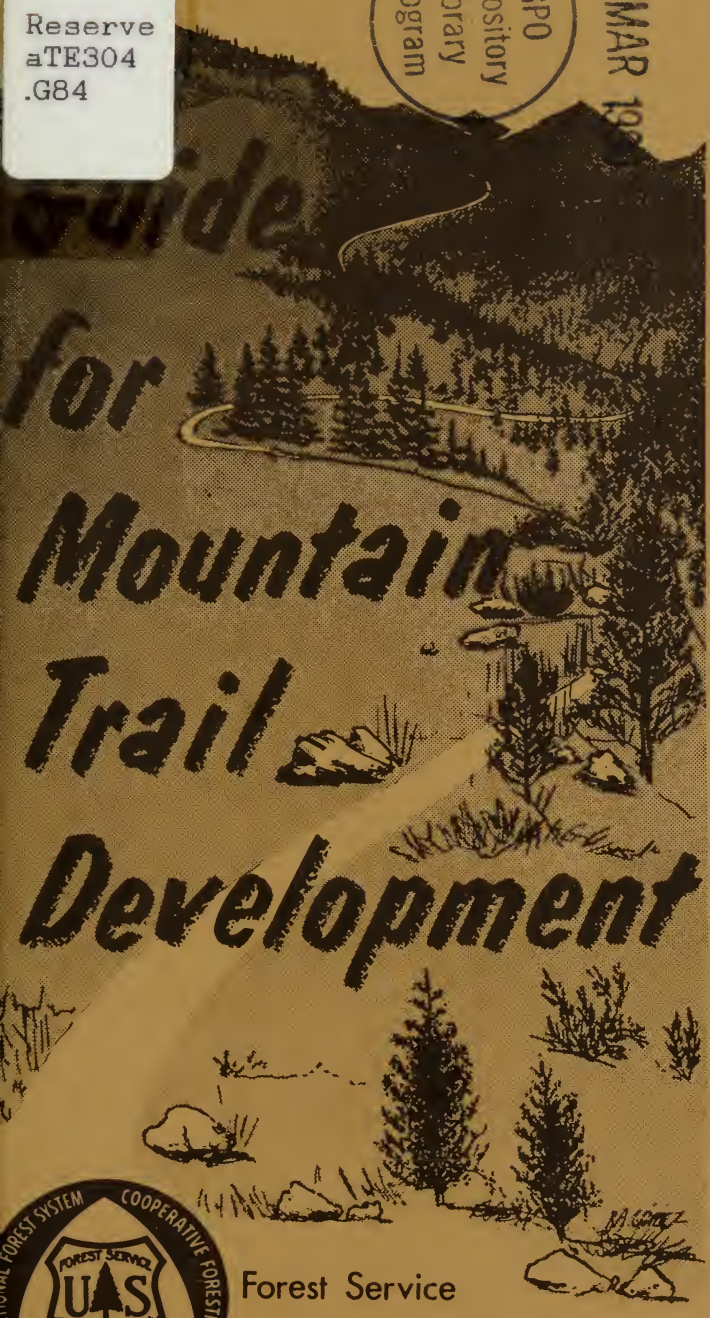
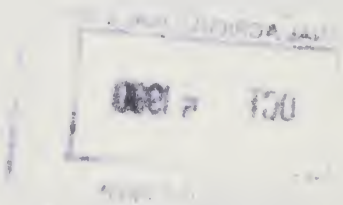
Guide for Mountain Trail Development



Forest Service
U.S. Department of Agriculture
Rocky Mountain Region

Guide for Mountain Trail Development



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INTRODUCTION

This Trail Guide has been prepared by the Engineering Staff Unit and contains basic information for new Forest Service employees or volunteer personnel working on hiker and horse trails in the Rocky Mountain Region. The contents represent a condensed version of information contained in Forest Service Manuals and Handbooks and practical experience gained in the field. The Trail Guide is published in pocket size so that it can be carried in the field for ready reference.

The Trail Guide covers normal problems and practices in the field. Should specific problems be encountered that are not covered, they should be referred to the appropriate Forest staff member for technical assistance.

The order of discussion in the Trail Guide is the normal sequence in which trail development occurs. As a user of the Guide, you are encouraged to submit any comments you may have as to the usability or completeness of the information contained herein.

SAFETY MESSAGE

The applicable sections of the Forest Service Safety Code, Occupational Safety and Health Administration Regulations, and other related Federal agency standards must be followed in trail work. New employees will be given safety instructions before going to work. Persons engaged in this type of work must be in good physical condition. They will be trained or tested to assure that they are able to competently use all of the tools on the job. Trail crews normally work in isolated areas where doctors are not readily available, and transportation of an injured person is often difficult and dangerous. A good safety record depends on being safety conscious at all times. This applies in camp as well as on the job. One member of the crew may be designated responsibility for safety, but every member of the crew should consider himself the safety inspector for the job by working in a safe manner and pointing out unsafe practices to other crew members.

Location Guidelines

LOCATION GUIDELINES

Trail location objectives are to provide a facility on the ground that produces a minimum physical impact on the land, is visually pleasing, requires minimum maintenance, and functionally provides for the intended use. In addition to a knowledge of the criteria listed, the locator must have a "feel" for the "as-constructed" trail as he proceeds along the selected corridor. This "feel" or mental perspective is gained through experience in laying out trails, seeing them built, and critiquing the final product against the original location criteria.

The locator must be aware of the adjacent terrain, vegetation, soil types, and moisture conditions. All of these factors will directly influence how the trail should be located and subsequently how well the constructed trail will function.

The following General and Specific Criteria should be used as a guide:

I. GENERAL CRITERIA

A. Use existing trails as much as possible.
B. Terrain and elevational variety should not be extreme; suitable for family backpacking.
C. Locate predominantly or all on National Forest, other Federal lands, State, or private lands in descending order of priority.
D. Route is suitable for long season of use while maintaining ecological variety, i.e., not all alpine or all foothills.
E. Locate where suitable for both winter and summer activity to the degree terrain and climatic patterns will accommodate it.
F. Provide access points to towns, villages, or trailheads preferably at 3-day intervals.
G. Exposure on high elevation ridges should not exceed 6 miles.

H. Trail will meander to take advantage of scenic panoramas, historical, and resource management situations for interpretation purposes.
I. Trails should not make great or sudden changes in elevation.
J. Trail grades should contour rather than undulate up and over steep topography.
K. Main trail networks should disperse visitors away from fragile or heavily used areas.
L. Avoid trail locations along heavy use roads. However, roads, skid trails, etc., having few travelers may be used to avoid the soil disturbance associated with new trail construction.

II. SPECIFIC CRITERIA

A. Wildlife

1. Avoid elk wallow areas.
2. Avoid calving grounds.
3. Winter trails should avoid areas where big game species concentrate.
4. Provide vistas, observation points, or overlooks for observing wildlife in areas where they are likely to be seen.
5. Avoid bighorn sheep spring and winter range.

B. Soils

1. Locate on stable soils except where short sections, up to 50 yards, can be structurally contained and/or a relocation would create more conflict.
2. Locate trail around extended bedrock areas.

C. Water

1. Locate trail to overlook streams and

lakes and not follow along the water's edge.

2. Meander trails to provide water access points for users as well as pack and saddle stock.
3. Try for water access every 4 hours of walking.
4. Bridge crossings should be avoided if a relocation of the trail can make the structure unnecessary.

D. **Safety Hazards**

1. Avoid talus slopes or rock slide areas.
2. Avalanche zones should be avoided.
3. Avoid areas with concentrated numbers of snags. (If not practical to avoid, plan to remove snags during construction that are adjacent to the trail.)
4. The trail should avoid areas with erosion, snowbank, bogging, or icy surface potential.
5. Avoid severe high wind and lightning-prone areas.
6. Take advantage of natural shelter.

E. **Wild Outdoor Atmosphere**

1. Take advantage of natural vegetation and terrain to maintain a wild outdoor feeling where possible. These will become a part of the overall educational potential — some wilderness, some historical, etc.

F. **Cultural Features**

1. Retain cultural representation in harmonious blend to promote understanding of total resource management and its importance to the American citizen and foreign visitors by providing views and sounds of man's activities when appropriate,

such as harvesting timber, raising and harvesting crops, livestock ranching, industry, urban areas, and transportation facilities, without conflicting with the activities.

G. **River, Highway, and Railroad Crossings**

1. Provide safe crossings by means of bridges or underpasses except at low volume roads or railroads that can be safely crossed on grade. Special attention should be given to the safety problem that traffic noise can create for horsemen.
2. Provide adequate visibility when roads or railroads of low traffic volume are crossed at grade.
3. Take advantage of natural or existing features to afford an easy and quick crossing without breaking the continuity of the trail.
4. Utilize existing crossings of multilane freeways or major rivers where the cost of providing an exclusive trail crossing would be prohibitive.
5. Trail will enter and leave water on a descending and ascending grade to prevent water from draining down the trail.
6. Stream fords should be over cobblestone-size or smaller rocks. Avoid or remove 10-inch diameter or larger rocks in abundance that make horse crossings dangerous.
7. Trail crossings over or under features such as roads, aqueducts, underpasses, bridges, and power transmission lines will be made at right angles to avoid prolonged visual contact with them and to minimize cost if a structural installation is necessary.

H. **Provisions for User Facilities**

1. Provide access at varying distances along the trail so users can choose different trips of varying lengths.
2. Provide areas where stock may be controlled away from camping sites.
3. Take advantage of nearby areas where parking areas, campgrounds, stock handling, or other trailhead facilities could be located.
4. Allow space for hitching rails near the trail so riders can secure their horses at rest stops and scenic places.
5. Provide spur access to campsites rather than locating the main trail through the camp.

I. **Alignment**

1. The ideal alignment will "fit" the trail to the ground and afford the user the best views from the trail. The alignment should follow the contours of the land and be generally curvilinear. Sharp, angular turns over 50 degrees and long, straight stretches should be avoided.
2. The alignment should angle across the natural slope of the hillside rather than take a route directly up or down the slope which affords little opportunity to drain water away.
3. If a switchback is necessary, it should be constructed as shown in "Details of Switchbacks" (see Appendix). The most desirable alignment for a switchback utilizes a topographic feature as a turning point so that it does not appear to be "carved" out of the hillside. Provisions for screening and protecting the switchbacks with trees or brush should be incorporated in the design when the trail cannot be

constructed around a natural topographic feature.

J. **Grade**

1. As a general rule, the trail should not be steeper than 7 percent (7-foot rise in 100 linear feet). Grades of 1 to 7 percent are ideal. Grades from 7 to 10 percent should not exceed 1,000 feet in length; 10 to 15 percent grades should not exceed 600 feet in length. No grade should be so steep that erosion is a problem. Do not locate zero grades. As a general rule, some grade must be provided to adjust to drainage needs. Long stretches of a given grade should be avoided. The grade should undulate gently to provide natural drainage and to eliminate monotonous, level stretches and long, steep grades that are tiring to the traveler. Grades should be lessened at approaches to switchbacks, and the turns should be as nearly level as practical.
2. A trail designed especially for hikers may incorporate short sections of steps or steeper grades within the controls indicated if these will not cause undue disturbance, and adequate drainage can be provided to prevent erosion.

III. SPECIAL SITUATIONS

The general and specific principles of trail location will apply to most of the land managed by Federal agencies along the length of the trail. There are, however, special situations which may require some modification of the location criteria.

Location of trails in Wilderness, lands controlled by Federal agencies other than Forest

Service, or on State, County, or private lands requires considerations beyond the criteria discussed herein. If you have not had previous instructions in these situations, consult with the local Ranger.

Design Guidelines

DESIGN GUIDELINES

The design of a mountain trail should be in keeping with the purpose of the trail. In general, it should be designed to produce minimum disturbance to the natural environment and should consider the protection of the adjoining resources, the safety and enjoyment of the user, the volume and type of traffic, and related economics. The design should incorporate features that reduce adverse impacts upon the environment, that result in a trail of high quality and permanence, and that provide the least cost to maintain.

I. SPECIFIC DESIGN ELEMENTS

A. Dimensions

Trail dimensions will be based on the type and volume of use anticipated, stability of the native materials, and type of terrain along the route. Generally, the trail tread width will be not less than 18 inches minimum for foot trails and 24 inches minimum for horse trails. Thirty inches should be the maximum tread width unless additional width is required for safety or impacts from heavy traffic.

The following exceptions are noted:

Along a precipice or hazardous area, the trail base should be at least 48-60 inches wide in order to provide safety to the hiker and horseman. Local heavy traffic or use by wheel-chair handicapped may require a two-way trail to accommodate passing use.

Special trail sections, such as fords through small streams or built-up sections across flat areas, should have a usable tread at least 36 inches wide. At switchback landings,

graded trails should be designed to minimize the amount of excavation and cutbank exposure.

The specific details of the trail's dimensions are shown in the Appendix.

B. **Clearing**

Clearing requirements vary with the intended trail use. For clearing dimensions, see discussions under Construction Guidelines and the diagrams in the Appendix.

C. **Structures**

Materials used for structures generally should be of a quality to permit long life. Structures should be built to the standard currently in use by the agency administering that land area and be designed to harmonize with the surrounding environment (see Appendix). Minor structures such as log corduroy, elevated sections (puncheon), retaining walls, and foot bridges (under 30 feet) may be built of suitable native materials if they are available near the site. When native materials are used, the site from which they were removed should be left with a natural appearance.

In designated Wilderness, structures should be limited to those necessary to provide safety to the user, be built from native material when possible, and conform to the requirements of the Wilderness Act.

Where a bridge for horses is not necessary, stepping stones or a large log with hand railing may be provided for hikers (see Appendix).

The crossings of major rivers or highways will require special designs. These

will be provided by the Forest Engineer.

D. **Drainage**

Surface and subsurface water can be handled in many ways. A discussion of various methods and design standards is covered in the Construction Guidelines and illustrated in the Appendix.

E. **Trail Surface**

Tread surfacing material which will blend with and preserve the natural environment will be provided where native soil cannot support the traffic, as necessary to minimize severe conditions of erosion, dust, mud, or when crossing slide rock areas.

F. **User Facilities**

User facilities such as trailhead loading docks, sanitary facilities, parking areas, huts, and water supplies are items which require individual analysis and design. If it is administratively decided to construct such facilities, the Forest Engineer will provide plans and guidance.

G. **Revegetation**

During design, plan for adequate revegetation of cut and fill slopes, borrow pits, or other areas where surface vegetation has been removed. Followup action must also be included after initial seeding to assure complete restoration of vegetation. Seed mixes, volume of application (pounds per acre), and season of application should be keyed to local conditions.

Construction Guidelines

CONSTRUCTION GUIDELINES

I. CLEARING

A trail designed for horse use will be cleared of all projecting limbs, brush, downed logs, debris, and sapling trees to a minimum width of 8 feet and a minimum height of 10 feet above the trail tread. Overhead clearing should permit a man on horseback to ride over the trail without interference from limbs and brush.

A trail designed for hikers only will be cleared of all small limbs, trees, brush, downed logs, and debris to a minimum width of 6 feet and a minimum height of 10 feet above the trail tread.

Travelway Clearing (see Appendix) shows the clearing dimensions graphically. Clearing beyond that necessary for adequate room along the trail may be desirable to provide openings so the traveler can enjoy a particular scene. These clearings should be planned to give the appearance of a natural opening and to enhance a scenic vista. The Forest Landscape Architect should assist in laying out these openings.

For protection against erosion and for the appearance of the area, leave all healthy trees over 10 inches at the base diameter which will not interfere with loaded pack animals. In sparsely timbered country, do not remove any healthy trees except where they interfere with trail traffic, and the trail cannot be relocated to eliminate the interference.

Cut trees 3 feet above the ground when stumps will be removed by blasting or pulling. (NOTE: Explosives may only be used by a certified blaster.) This will provide enough of a stem to give good leverage for pulling with a winch or other device. Remove trees and

stumps if the tree roots will interfere with grading. Cut all brush flush with the ground. Cut all dead or leaning trees which might fall across the trail. When trees are removed only to provide pack clearance, cut the stumps as nearly flush with the ground as practical; do not pull them.

Cut off green limbs flush with the tree trunk to permit the cut to heal over. Widen clearing areas at waterholes, resting places, and scenic points where stock may pass while the riders of one party are dismounted. Widen clearing on the upper side to permit passing at intervals in places where sideslopes are light.

II. BASE CONSTRUCTION

A. General

Do not unnecessarily disturb the existing ground surface to obtain a trail base, especially on flat areas. Construction of sidehill trails usually requires grading a shelf for the trail, but if the existing surface is flat and provides a suitable tread, leave it undisturbed. This will reduce erosion and maintenance. On level ground, form the trail base by building up rather than cutting down. Remove all duff before making cuts or fills for the tread.

Start grading at the upper slope stake and carry it down to the finished grade. The usual procedure is to "scratch" a continuous line between the upper slope stakes using a shovel or pulaski. Remove any excess duff at this time. Begin excavation along this line using the mechanical grader, a plow and trail grader combination, hand tools, light tractor, or other means. Keep the working surface approximately level or slightly insloped until the final grade is reached. On

slopes 20 percent or over, the trail base should be constructed totally in native soil. Fills on slopes above 20 percent are hard to maintain and are often unsafe for horse traffic when slopes exceed 40 percent.

A soil berm along the outside of a trail should only be used when the trail fill consists of loose, disintegrated granite or other unstable material which may erode easily. The use of a soil berm is related to special handling of surface runoff drainage (see Appendix). A rock berm should be used for safety on horse trails when the sideslope is 80 percent or greater to keep the horse from walking on the outer edge. Trail base width should also be widened to provide adequate tread area. If soil or rock berms are used, it should be recognized that more frequent maintenance is usually required to keep the berm intact. In addition, mechanized maintenance on the trail is not practical.

Various track-mounted machines such as the Morrison Trailblazer and Case 350 Tractor have been used for trail construction. The most-used machine is a nonriding, mechanical-powered grader (RotoCat). Its use is further described here. It is a mechanical device operated by two men and excavates and removes the material as it proceeds. If a grader is available for use, the following guidelines should be used:

1. In marking the line between the upper slope stakes, make the "scratch" line deep enough so the front-end operator, who proceeds backward, can "feel" and follow it with his feet while watching the cutting blade.

2. The forward man is responsible for the depth of the cut, and the rear operator controls the speed of the machine, speed of the cutter, and operation of the engine.
3. For one operation, select a length of section that can be completed in a half day, a stretch between construction control points such as rocky sections, switchbacks, or points where the machine can be readily turned.
4. On normal slopes, make the first cut about 3-6 inches deep (to bottom of duff) with the rotor turning at sufficient speed to throw the duff well beyond the trail prism.
5. Normally, five passes are necessary to complete the trail. Make the second cut on the inside. Offset the proper distance from the first cut to form the proper backslope. Reduce the rotor speed so the excavated material remains in the trail prism. On this cut, tilt the machine toward the backslope. Make the third cut along the outside, and daylight the second cut. The fourth and fifth cuts repeat the process of the second and third cuts, and, under normal conditions, complete the machine portion of the construction job. On gentle slopes, three passes of the machine may be sufficient, and on steeper slopes, seven trips or more may be necessary.

NOTE:
Before using turnpike, puncheon, or corduroy sections, make every effort to locate the trail around the problem area.

B. **Turnpike Sections**

Turnpiking is a process of utilizing material from parallel side ditches to build up the trail base (see Appendix). Their use is primarily in flat areas that are wet or become wet during the rainy season. The most important consideration is getting the water level down below the trail base and carrying the water under and away from the trail at frequent intervals. When ditch material is of poor, boggy soil, it will be necessary to import better material from nearby to build up the base. Blasting techniques can be used to form these ditches. However, only properly trained and certified personnel can do this work.

C. **Puncheon**

Puncheon construction utilizes sawn, treated timber or native logs to elevate the train tread above wet areas that are not feasible to drain nor to utilize a turnpike section (see Appendix).

Puncheon consists of a 5-foot-wide deck of native logs, or sawn, untreated planks laid on stringers. Treated, sawn planking may sometimes be used economically. The deck is laid on stringers set on mud sills. The stringers are generally placed at each edge of the widened trail at about 4-foot centers. The mud sills are set at right angles to the trail at 6- to 8-foot intervals. Provide proper subdrainage under the stringers and mud sills (see Appendix).

Take care that puncheon is level from side to side and that the entire structure extends far enough so that soft spots or jumpoffs do not develop at the ends. Approaches to each end must be installed on a modest grade not exceeding 5 percent.

Securely spike the decking to the stringers and spike a binding pole or guard along each edge to keep traffic in the center of the puncheon. Where practical to do so, the utility and life of the structure can be increased by covering the deck with a layer of dirt to cushion the traffic and save wear on the deck planks caused by shod horses.

Filling small, boggy places in the trail with large, flat rocks comes under the general heading of puncheon. This is an effective way to treat these places; but, to give a satisfactory footing, cover the rocks with gravel or other stable material as a tread surface.

D. **Corduroy**

Corduroy construction is basically a primitive type of puncheon. It consists of laying three native logs (about 6-inch diameter) on the ground as stringers with 5-foot cross logs (4- to 6-inch diameter) laid side by side across the stringers and bound together with wire or nails. If native soil is placed over the deck, logs should be lashed along the edges to retain the material. Flatten the top of the deck logs for ease of walking if soil is not used. Corduroy, normally short-lived, is considered as a temporary crossing until a more permanent solution can be installed (see Appendix).

III. TREAD CONSTRUCTION

Normally, the native soil used to construct the trail base is adequate to carry foot and light horse use. Select surfacing (tread) is a costly item and should only be used for extreme needs such as on heavy use trails, in wet areas, across rock slides, or to provide footing across solid rock areas.

When surfacing is required, pit run native gravel in the area should be used first. If no gravel is available on site, consider importing from farther sources. Gravel is usually found around streambeds or in small pockets along the trail. It is loaded by hand and hauled by duffel carrier, wheelbarrow, or in packhorse panniers. Because of the relatively high labor cost per cubic yard of material in place, the source location is of greater importance than the quality of material. In other words, from a cost standpoint, a poorer material close by may be more desirable than better material farther away.

The depth and width of surfacing must be determined in each case based on the quality of the native material and the use anticipated on the trail. As a general rule, 3 inches of gravel will last about 5 years with 10-15 horses per day over the trail.

IV. SWITCHBACK CONSTRUCTION

Switchback construction requires good initial trail centerline reconnaissance in relating its location and layout to the existing terrain.

When switchbacks are necessary, construct the turns as flat as possible. On sideslopes of less than 20 percent, treat the switchback as any other section of the trail by following a long, radius curve. If this results in the centerline grade being steeper than is desirable, shorten the radius and build a conventional 8-foot radius switchback with the grade of the upper and lower legs meeting at the radius point. Start excavation along the upper slope stakeline of the upper leg, and carry down to grade at the radius point before starting the lower leg. In order to provide proper drainage, carry the upper leg cut well out beyond the radius point, then shape and complete the turn area (see Appendix).

Log or rock barriers should be installed between the lower and upper legs of the switchback. Provide 15-30 feet of barrier back from the turning point to prevent foot or horse traffic from crosscutting inside the switchback creating ruts followed by erosion.

V. DRAINAGE

A. General

Drainage control on a trail relates to two primary types of water control, surface and subsurface water.

Any provision for the discharge of surface water must include precautionary measures that will prevent silting, erosion, or gullying of areas off the trail. Rock placement at the discharge point will help dissipate the water and stop erosion.

B. Surface Water

Surface water is the water from rain or snow that, before the trail was built, flowed in a sheet along the natural ground surface but is now cut off and channeled into the trail. This water will flow along the trail, and if allowed to accumulate above a certain critical combination for soil type, slope, and velocity will erode the trail surface.

The methods of diverting surface water are by outslope, grade dips, water bars, ditches, and by varying the trail grade when it is constructed. Intercepting ditches appropriately located above the trail in wet, swampy areas and led into the drainage structures located under the trail can also be used to advantage to minimize erosion on the trail.

C. **Subsurface Water**

Perhaps the most troublesome drainage problem in trail construction is subsurface water. The best solution to extensive subsurface water on flat ground is to relocate the trail on the sidehill and bypass the trouble. If this is not practical, the next best solution is to lower the water table and permit the ground above to dry out sufficiently to support the trail loads. As a last resort, puncheon or corduroy construction should be used. In some cases, a drain ditch can be dug by hand or machine to divert the water into a stream. In areas that are too wet for ordinary methods, it is possible to blast drainage ditches by using ditching powder. This method should be used only by men who have been properly trained and are certified in this type of work. Drainage ditches that can be left open should be designed and built to provide continuous service without unusual maintenance. Perforated culverts or French drains may be used when open ditches are not practical (see Appendix).

Occasionally, trail construction on an apparently dry hillside will open up subsurface water in the form of springs. A small collection ditch that leads the water to a culvert under the tread will solve this drainage problem. A small amount of water is not objectionable if allowed to flow across the trail undisturbed, provided the trail base and tread will not become boggy.

D. **Drainage Facilities**

1. **Outslope**

Outslope of the tread is probably the best method and the one most commonly used to divert surface water.

This method requires periodic maintenance of the tread to prevent the formation of a rut and channel in the trail. Outslope should not exceed 1 inch in 18 inches except at dips, where it should not exceed 4 inches in 18 inches. Outslope is most satisfactory when used in combination with grade dips.

2. **Grade Dips**

   Grade dips are sections of trail where a short piece of the trail, generally not over 5-6 feet, has been built with a grade slightly adverse to the prevailing grade of the trail (see Appendix). This prevents the flowing water from passing that point. The trail is outsloped at the low point in the dip to divert the water from the trail. Grade dips are most satisfactory when they are built into the original construction, and the designed grade allows for the adverse grade. When grade dips are built into an existing trail, the upper portion generally is too steep for proper maintenance. Instead of building grade dips in an existing trail, it is customary to build water bars.

3. **Water Bars**

   Water bars are generally made with an 8- to 10-inch diameter log laid at a 20- to 25-degree angle with the trail and fastened in place with heavy stakes, posts, or steel pins. Light rebars or wire mesh may be used for reinforcing if a soil cement installation is made. Well-embedded rock may be used if logs are not available (see Appendix).

   Make the tread flush with the top of

the log, downgrade from the water bar. Upgrade, make the tread approximately at the center of the log. Immediately above the water bar, slope the outer edge of the trail outward to permit release of the water.

Earthen water bars can also be constructed from the natural mineral soil located within the trail prism without benefit of rock, log, or other materials when the trail grade and surface runoff are moderate.

This type of water bar adapts itself to installation in a trail at the low undulating dip sections. Earthen water bars should not be constructed in unstable material when trail grades exceed 7 percent or on high-use horse trails.

4. **Culverts**

Metal, wood, or rock culverts are one means of draining wet spots or passing small streams under the trail base. Aluminum culverts are currently popular in use when a metal culvert is desirable in a trail, primarily due to their light weight in transporting long distances into the back country and ease of handling during installation. They must be adequately covered (minimum 12 inches) as should all metal culverts to avoid puncture, especially from shod horse traffic (see Appendix).

5. **French Drains**

French drains consist of a systematically placed row of rocks, graduated in size, usually placed in a boggy or springlike water source, usually below the subsurface. This

structure in effect collects the local water in the trail area and transmits it under the trail base, usually permitting a dry trail surface. If an adequate volume and graduated size of rock are available within a reasonable distance of the planned installation, the structure is a cheap and effective way to drain small, wet spots on the trail. To be effective, however, the drain must be on a gradient (2 percent minimum, more if drained area will permit) to permit gravity to assist in the drainage operation (see Appendix).

6. **Fords**

Fords are generally selected rather than constructed, but there are times when some improvement of the stream channel is required to provide good footing. Often fords are necessary in conjunction with a bridge, with the bridge for foot use, and the ford for pack and saddlehorse use. Fords should not be used when the water is swift or the water depth exceeds 3 feet during the normal season of use. Safety of the user is a major concern in determining whether to use a ford or bridge.

In fast-moving streams, the tread across a ford often can be improved by pulling the larger rocks into a line across the stream parallel with the trail and below the downstream edge of the crossing. This allows sand and gravel to deposit above the barrier and develop a smooth, level tread. In slow-moving streams, move the larger rocks out of the way to improve footing for horses.

Construction of a ford consists of widening the trail base to a 36-inch minimum, removing large rocks, and leveling of the stream bottom to make a relatively smooth and level crossing for foot or horse traffic. Trail gradient into and out of a ford should be graded to keep the water from running down the trail (see Appendix).

VI. STRUCTURES

The use of structures in the back country should be held to a minimum. Alternatives should be considered, including the economics of using native versus prefabricated materials. Transportation of materials by pack animals, duffel carriers, or helicopter is expensive. Hand methods of construction are normal, and the size and weight of pieces become important. Special designs may be necessary to facilitate transport and construction of the structure.

A. Bridges

No bridges will be built on new or relocated trails likely to be in service indefinitely until the Forest Engineer determines the most economical type of installation and provides construction plans or guidance.

The basic difference between a horse and foot bridge is the load-carrying ability and width of the structure. Construction practices and procedures are normally the same. Several diagrams of typical bridges are included in the Appendix.

When native logs are used, the selection, preparation, and fabrication of the logs should be guided by the following:

Logs to be used as stringers for bridges should be carefully

selected. All stringer logs for any one span should match in diameter, taper, and inherent stiffness. They should be straight, sound, free of scars, cat faces, wind shake, splits, or other defects which might impair their strength.

High standard workmanship in the selection, fabrication, and fitting of logs can mean the difference between a short-lived and a long-lived bridge. Cut the logs 1 year in advance. In order to reduce checks, season them with the bark on and peel them immediately before use. During the seasoning period, set them on blocks to keep them from contact with the ground. Have adequate equipment on hand for moving and handling the logs and other timbers. Insist on careful fabrication. Allow no misfit joints and uneven bearing surfaces; these will detract materially from the life of the bridge.

Care must be exercised in the selection of a bridge site, that adequate foundation is obtained for abutments and stream piers when bridge span requires them. Adequate high water and debris clearance under the bridge stringer is also of major concern to the life and useful service of the structure.

Bridge structures should normally be located at right angles to the stream they cross.

B. **Retaining Walls**

Retaining walls are structures of wood or stone designed to stabilize the trail base on a sideslope. Native logs should be used only if rock is not readily available and only when sideslopes do not exceed

50 percent. A solid foundation on earth or rock is a must to obtain a rigid, safe retaining wall (see Appendix).

The thickness of the rock wall at the base should be at least one-half the height of the wall, or a minimum of 2 feet if the vertical height is less than 5 feet. The outer edge of trail should be at least 6 inches higher than the inside.

Only rocks which are sound, durable, and have a good bearing surface should be used. The largest rocks readily available that can be safely handled should be used in the body of a wall. Smaller rocks may be used for filling voids. Round rocks should not be used in a wall.

Joints in walls should always be staggered at least 6 inches or more horizontally from the adjacent joint in the next course. At least one-fourth of the front and rear faces of the wall should be headers having a length at least two and one-half times their thickness. All projecting points should be removed from top and bottom of main rocks so that each is laid with good bearing on the broadest face. All headers must be laid with their greatest dimension extending into the wall and never parallel to it except at corners. Here, alternating headers should cross. The outer face of the wall should have an inward slope of at least 3 inches to every foot of height. The wall should have a front and rear face well tied together with header stones of suitable size.

Drainage should be provided around, beneath, or through the retaining wall so that water cannot accumulate behind it.

C. **Fence Gate, Stile, Fence Ladder**

Trail construction often crosses drift or boundary line fences. On horse trails, a wooden gate is preferred. In some instances, a stile or fence ladder may be required for a hiker trail.

A wood or wire gate will require the installation of a corner post and line brace on each side of the gate opening. The standard trail gate width is 6 to 8 feet and should be installed if horse and pack stock use the trail.

Stretch wire tightly and uniformly between the brace section and the main fence line. Use wire stretching tools made for the job. Never stretch wire with a horse or a vehicle.

The trail crew should refer to the Appendix and to the Forest Service Structural Range Improvement Handbook for instructions and use of fence construction equipment if they have no experience in this type of work.

Stile and fence ladder plans are included in the Appendix. A typical wood gate is included in the Structural Range Improvement Handbook.

Operation Guidelines

OPERATION GUIDELINES

I. SIGNING

A. **Regulatory, Warning, and Guide Signs**

Sign planning and procurement shall be done only in accordance with the requirements of the Forest Service Sign Handbook. Sign installers should be aware of the type of use and the season of use on the trail. This information is needed to most effectively locate the sign on the ground.

1. **Types**

There are three classifications of signs:

a. Regulatory signs give notice of laws or regulations such as "Trail open to foot traffic only."
b. Warning signs call attention to conditions on or adjacent to a trail that are potentially hazardous to traffic.
c. Guide signs show directions, destinations, distances, and identify features. Included in this classification are markers, but because of their special significance on trails, they will be discussed separately.

2. **Location**

The principal sign placement points are:

a. Trailheads
b. Hazards
c. Intersections
d. Boundaries of special management areas such as Wilderness
e. Major topographic features shown on maps, particularly

those that are destination points
f. Facilities such as campgrounds
g. Interpretive sites

3. **Installation**

Install signs so that the message can be easily detected and read by the user while keeping it within the visual scale of its surroundings. On summer hiking trails, a mounting height of 4 feet and placement at the clearing limits are standard. Signs should be mounted on posts — use double post where sign is longer than 36 inches. Face directional signs toward traffic; feature identification signs may be placed parallel to the trail.

Posts should be securely set into the ground at a depth of 2½ to 3 feet. It is preferable to use fasteners such as galvanized carriage bolts to aid removal for maintenance. Do not use trees as signposts (see Markers for exception), and do not attempt to anchor signs by piling rocks around the post.

B. **Trail Markers**

Markers are a series of symbols designed to reassure the trail traveler. Markers convey their message through the use of a standard shape, size, and color. They are designed to be a low cost supplement to other signing.

1. **Types**

There are four types of markers: trail blazers, blazes, cairns, and distinctive markers. The system used, except for rock cairns, should be consistent for the full length of the trail. The diamond-shaped trailblazer is the standard Forest Service marker for use

outside Wilderness areas; Forest Service tree blazes will be used inside Wilderness areas.

2. **Location**

   Locate markers immediately beyond crossing of roads or streams where the route is not readily discernible and as reassurance when other signing is widely spaced.

3. **Installation**

   In contrast to other signing, markers should be mounted on natural objects and, except for rock cairns, be at the user's eye level. When a tree is used for mounting, it is preferable that the tree be at least twice as wide as the marker.

   Trailblazers may be precut from metal, wood, or plastic and nailed up, or they may be painted on the tree using a stencil.

   Blazes will be used within Wildernesses and may be used on other trails. Blazing should be done only by personnel skilled in the use of an axe. The approved blaze is shown in the Appendix.

   Cairns are typically used in alpine areas where vegetation is low to the ground, and the maintenance cost of post mounts is high.

   Cairns should be constructed to resist extreme weather conditions and be intervisible and recognizable at a distance of 300 feet. Paint or other delineators are not to be used with cairns.

   Distinctive markers may be authorized for secondary identifica-

tion of special trails as determined by the Regional Forester. These markers would be used in lieu of the standard trailblazer.

II. MAINTENANCE

Maintenance is the upkeep of the entire trail facility as is necessary for its safe, efficient utilization and to maintain its originally constructed standard. The purpose of the trail determines what type of maintenance work is required. There is a priority on the order of performing the different types of maintenance work. Maintenance must provide for: (1) protecting the adjacent resources and safety of the permitted user; (2) preserving the investment in the trail itself; (3) user convenience.

Available time is always critical in mountain trail maintenance. There are usually more miles to cover than can be worked into short summer periods. Consequently, it is important that maintenance personnel understand why they are maintaining a particular section of trail, and that they perform only those maintenance activities needed to satisfy the objective. Although mountain trails have varied origins — from game trails to wagon roads — maintenance should be based on what the trail will be used for in the immediate future.

A. Maintenance Activities by Level of Maintenance.

1. Level One — Resource Protection and Safety

a. Safety

Work oriented to correct unsafe situations.

b. Drainage

Work oriented to ensure that drainage structures are functional and not likely to fail.

Remove silt built up against water bars. Reshape inlet to direct water across the trail. Place rock at outlet to disperse water flow. Replace crossbarrier if nonfunctional. Install intermediate water bars if trail erosion is evident between existing bars.

Clean the inside ditch to provide drainage off the end of switchbacks. If water is directed across the trail on the upper leg of the switchback, be sure it is directed across the lower leg of the switchback. Install or replace barrier logs or rocks to prevent shortcutting of the turn at the switchback.

Drain bog holes. Open drainage ditches and clean out culvert inlets and outlets.

c. **Tread and Travelway**

Maintain only at hazardous locations such as slide areas and narrow sections along cliffs and sideslopes over 100 percent lateral to the trail.

d. **Clearing**

Remove down trees across the trail, dead trees leaning over the trail, and limbs that force traffic off the established tread.

e. **Structures**

Remove debris that restricts water flow. Close if not structurally safe. Replace potential hazards such as rotten bridge rail or deck planks.

f. **Signs**

Install signs advising users of trail conditions or restrictions. Replace missing or unserviceable signs that provide essential directions or markings for user safety.

2. **Level Two — Preservation of Investment**

Perform the basic care of Level One plus activities to extend the serviceability of the trail up to its design life. Work activities listed below would be performed only after sufficient work has accumulated to make move-in and specialized equipment costs economically feasible.

a. **Drainage**

Replace temporary structures with permanent ones.

b. **Tread and Travelway**

Remove slides. Reshape surfacing for proper drainage. Repair potholes, and remove obstacles that would affect surface drainage patterns.

c. **Clearing**

Cut brush, trees, windfall, etc., to Level Three standards.

d. **Structures**

Periodically inspect for safety by qualified personnel. Replace unserviceable handrails and walking planks. Repair undercutting of piers and abutments. Protect structure with riprap. Repair retaining walls. Replace unser-

viceable logs in corduroy section.

e. **Signs**

Maintain all existing signing in a serviceable condition in accordance with Forest Service booklet, "Field Maintenance of Routed Wood Signs."

3. **Level Three — User Comfort**

Perform the basic care of Level One plus the work of Level Two on an annually recurring basis plus maintenance to enhance the user's experience.

a. **Drainage**

Minimize water crossing trail tread with ditches and culverts.

b. **Tread and Travelway**

Fill holes and smooth tread with select bank material that contains small rock. Do not use topsoil or light duff from the top layer on the ground. Import select material if needed. Drain small mudholes with an outlet ditch, fill with medium-size rocks, and cover with select material. Pull loose material from outside berm into the trail to eliminate the "cupped" effect produced by heavy wear. Remove rocks from the outside berm that extend above the trail surface. Remove loose rocks and tree roots from the tread. When crossing slide rock areas, transport select material to build up a tread. Provide additional base width where required for use or safety. Shape the tread

surface so that the outside edge is about 2 inches below the inside edge.

c. **Clearing**

Brush out annually to minimum clear distance required for the trail user. Maintain vistas and landscaped areas. Clean up damaged vegetation adjacent to travelway.

d. **Structures**

Maintain appearance; check for safety items — structural failure clues on bridges.

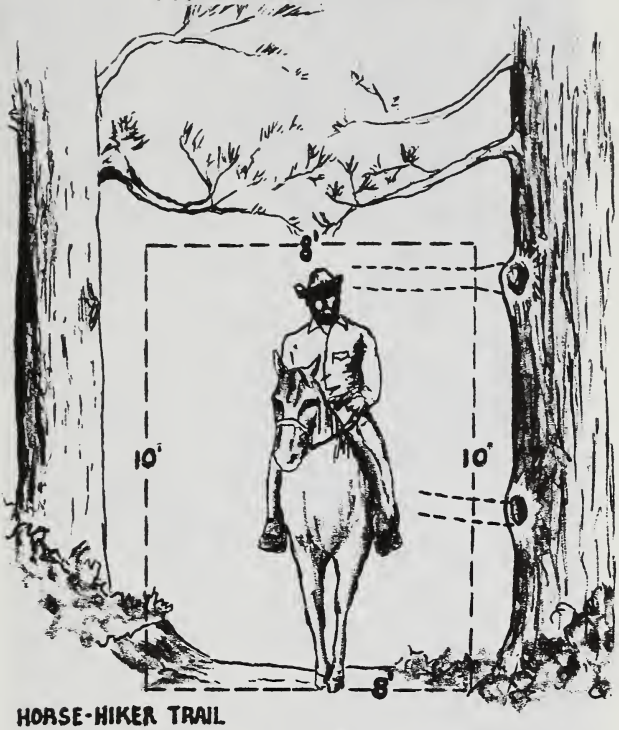
e. **Signs**

Maintain appearance. Provide identification and interpretive signs. Reset leaning or downed signs. Replace damaged signs. Reshape rock cairns.

Appendix

Diagrams

TRAVELWAY CLEARING



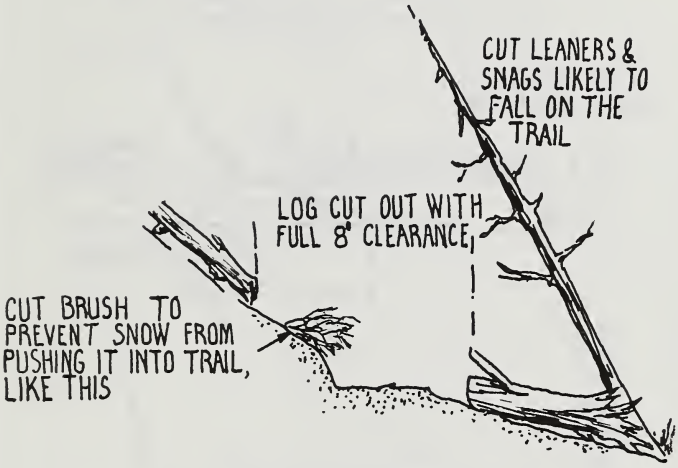
HORSE-HIKER TRAIL

HIKER TRAIL

WIDOW MAKER

REMOVE FOR SAFETY

GOOD CLEARING PRACTICE

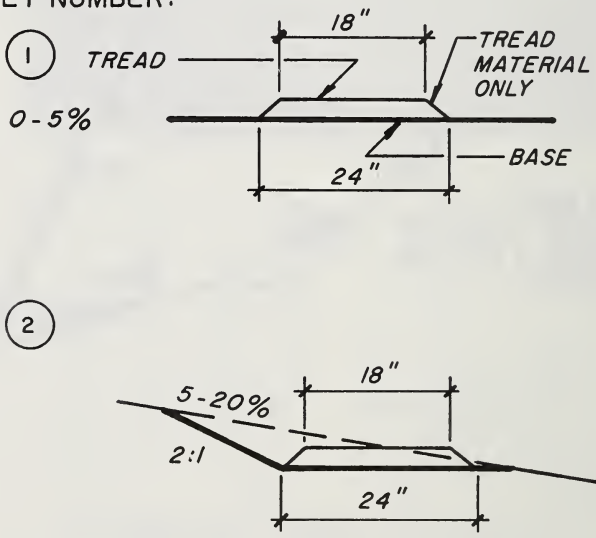


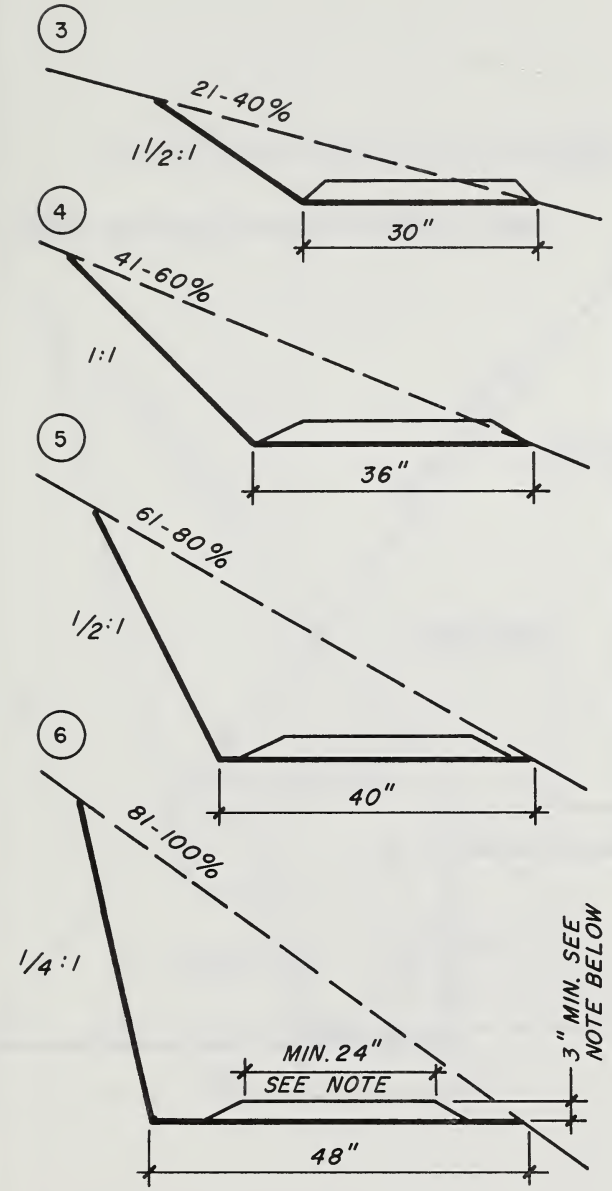
TYPICAL TRAIL BASE CROSS SECTION

DIAGRAM

1. Minimum base widths are in native material when slope exceeds 20%.
2. Sections 1-8 are applicable to all-purpose trails. Sections 1-6 are applicable to hiker trails. Minimum base width of hiker trails will be 48 inches when sideslope is above 100%.
3. Special (two lane) trail widths that are greater than indicated in typical sections 1-8 may be used in high use areas or for use by the handicapped.

TYP. SECTION KEY NUMBER:

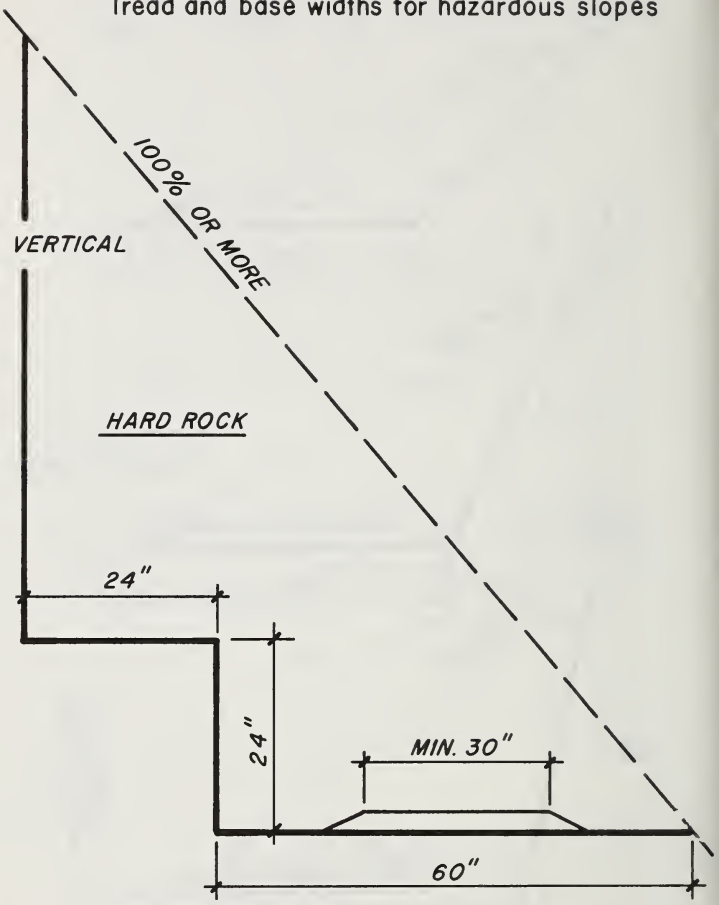




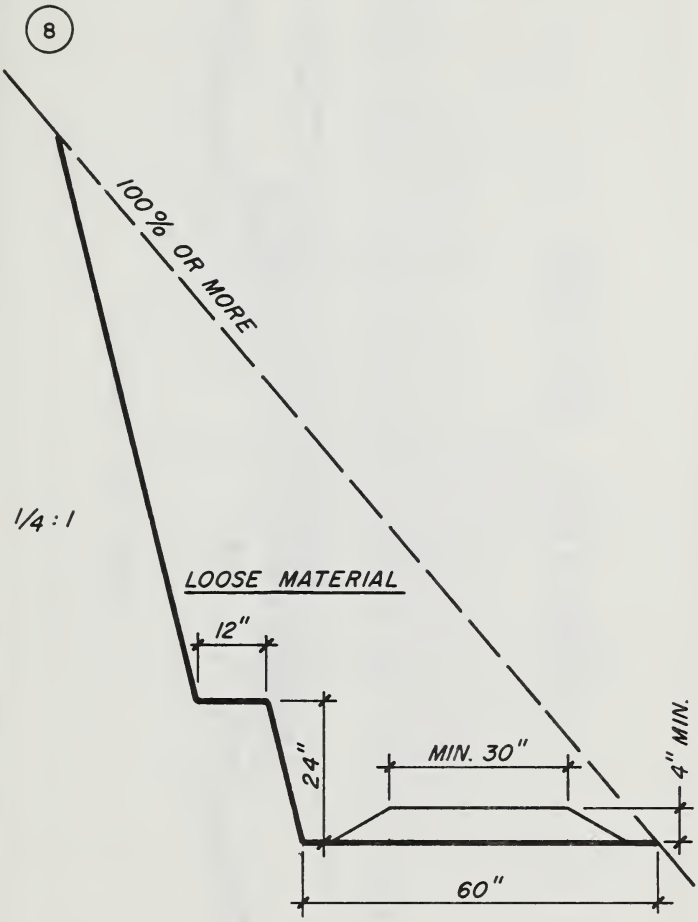
NOTE: TREAD WIDTHS ARE TYPICAL FOR SECTIONS 3 THRU 6. TREAD DEPTHS ARE TYPICAL FOR SECTIONS 1 THRU 7.

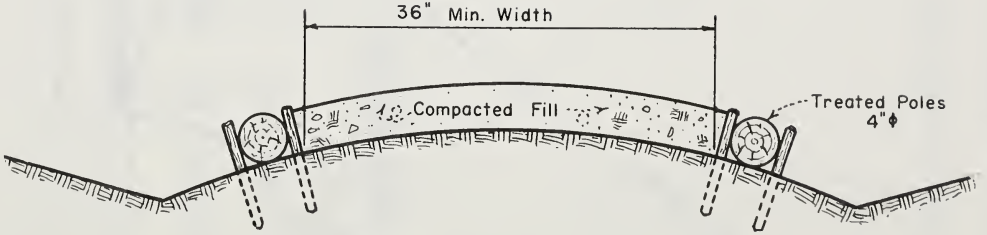
(7)

Tread and base widths for hazardous slopes

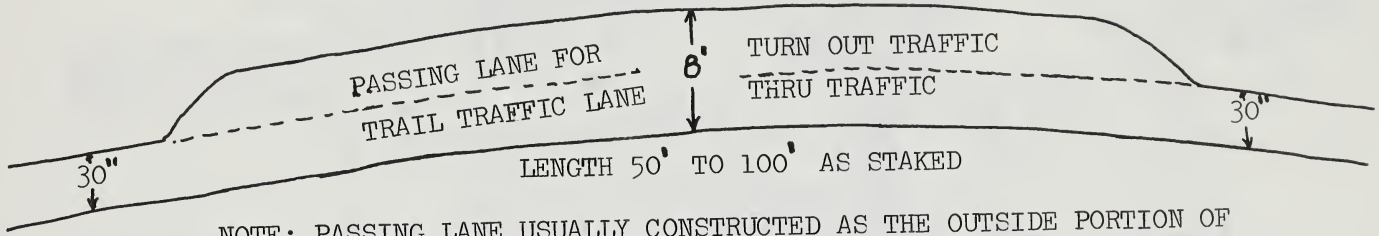


Tread and base widths for hazardous slopes



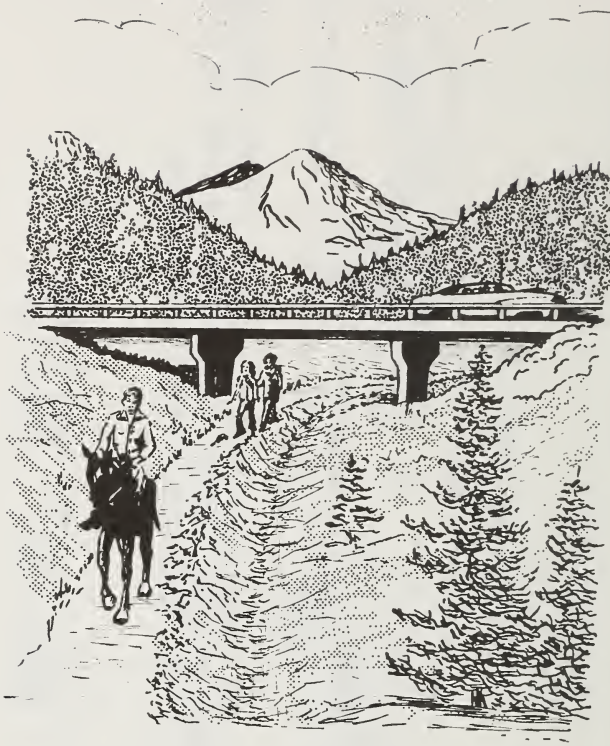


TURN PIKE SECTION

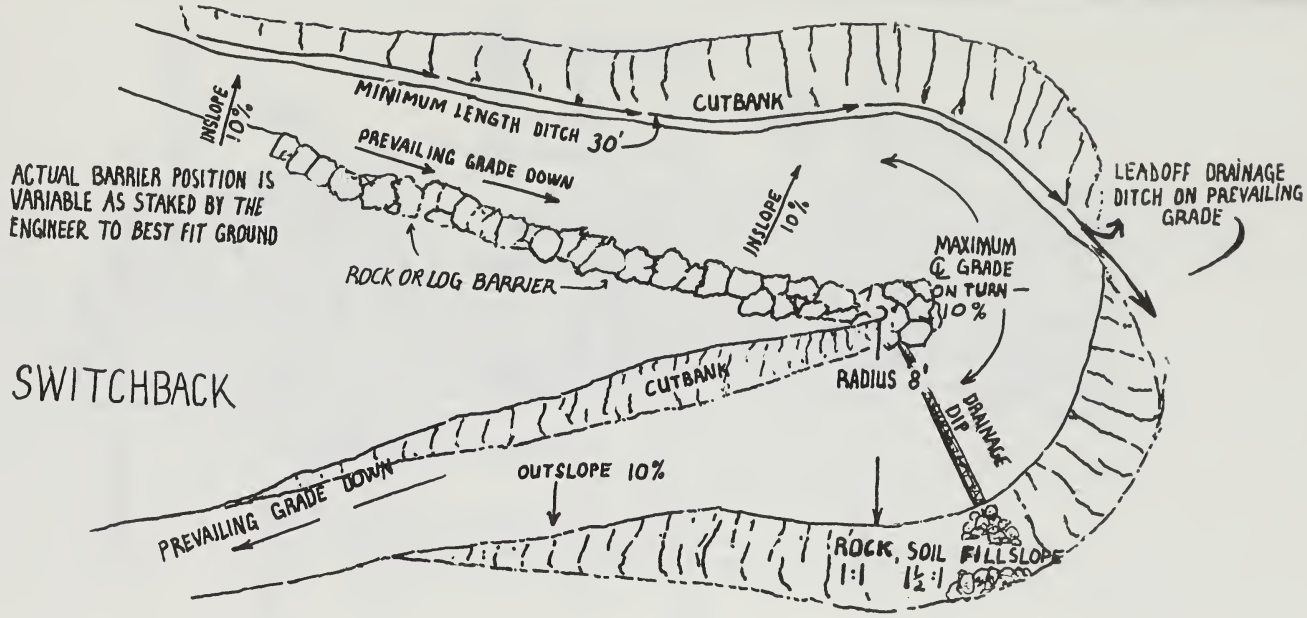


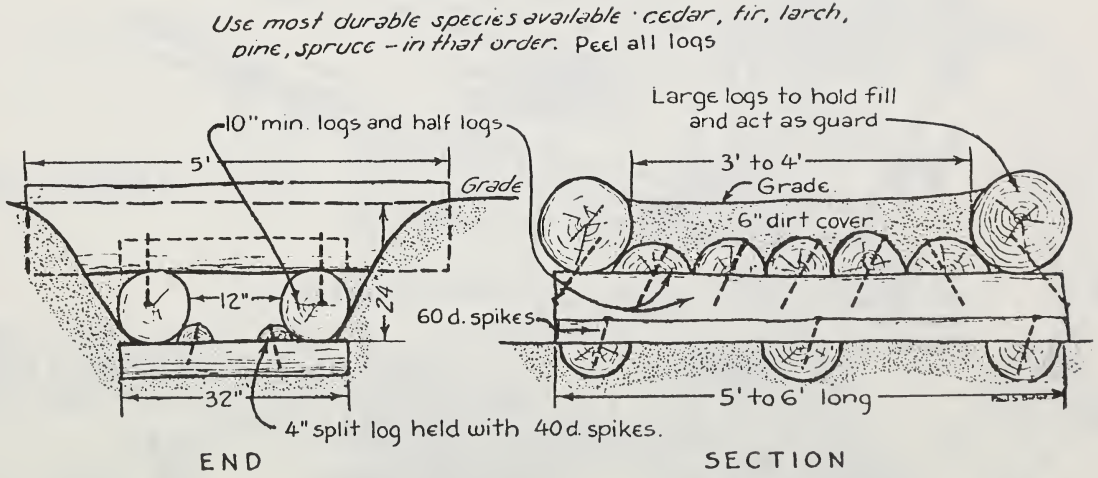
NOTE: PASSING LANE USUALLY CONSTRUCTED AS THE OUTSIDE PORTION OF THE WIDENED SECTION. ANIMAL PACK CLEARANCE MUST BE PROVIDED OUTSIDE OF THE DESIGNATED TRAFFIC LANE WIDTHS.

TURN OUT SECTION

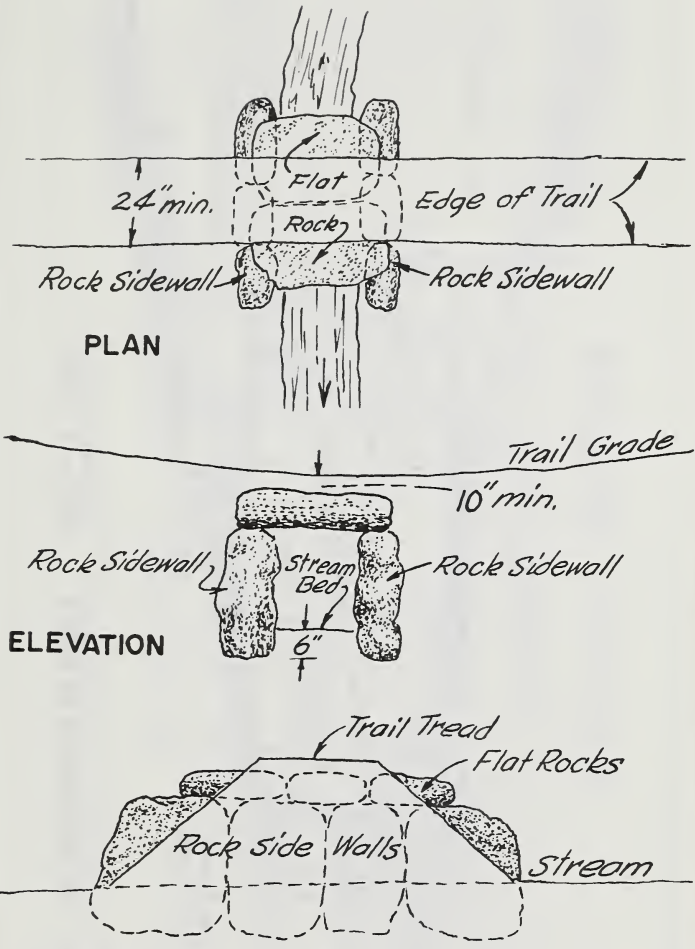


TRAIL PASSING UNDER BRIDGE

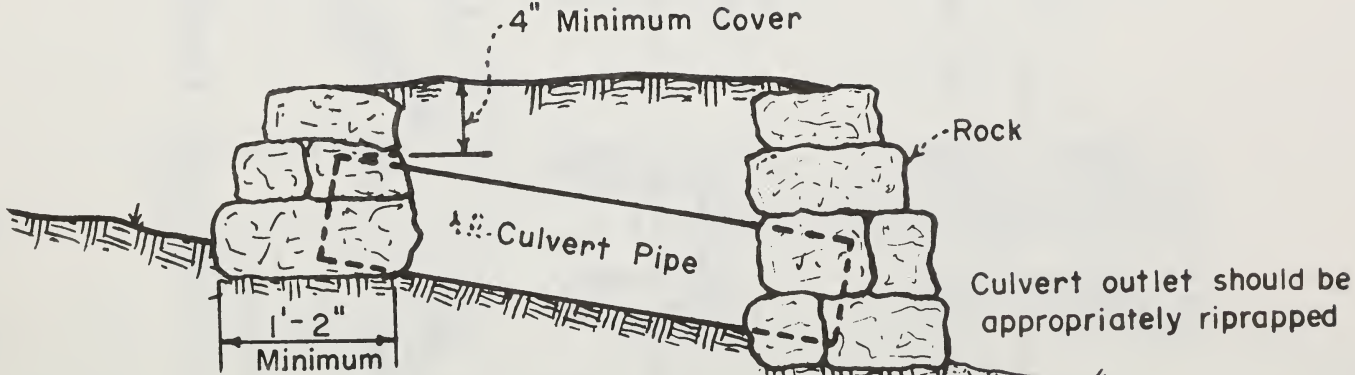

SWITCHBACK
INSLOPE 10%
MINIMUM LENGTH DITCH 30'
CUTBANK
PREVAILING GRADE DOWN
ACTUAL BARRIER POSITION IS VARIABLE AS STAKED BY THE ENGINEER TO BEST FIT GROUND
ROCK OR LOG BARRIER
INSLOPE 10%
MAXIMUM ℄ GRADE ON TURN 10%
LEADOFF DRAINAGE DITCH ON PREVAILING GRADE
RADIUS 8'
CUTBANK
DRAINAGE DIP
OUTSLOPE 10%
PREVAILING GRADE DOWN
ROCK, SOIL FILLSLOPE
1:1
1½:1


Use most durable species available · cedar, fir, larch, pine, spruce – in that order. Peel all logs
10" min. logs and half logs
5'
Grade
12"
24"
32"
4" split log held with 40d. spikes.
END
Large logs to hold fill and act as guard
3' to 4'
Grade
6" dirt cover
60d. spikes
5' to 6' long
SECTION

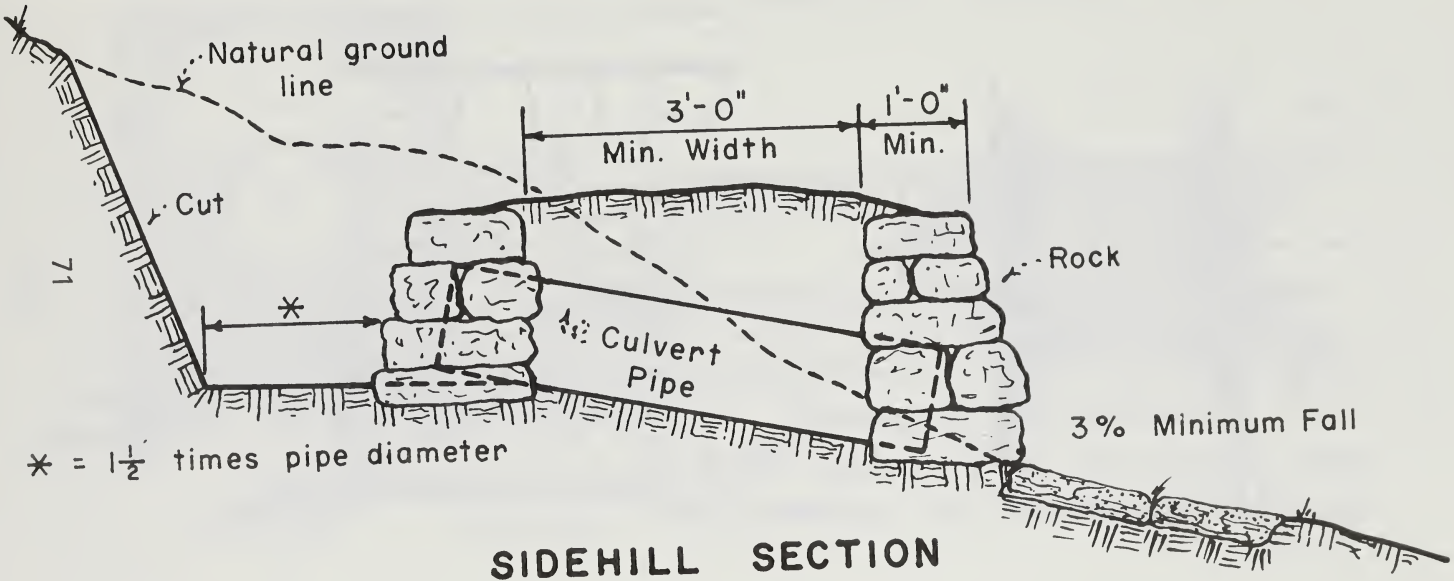
LOG CULVERT



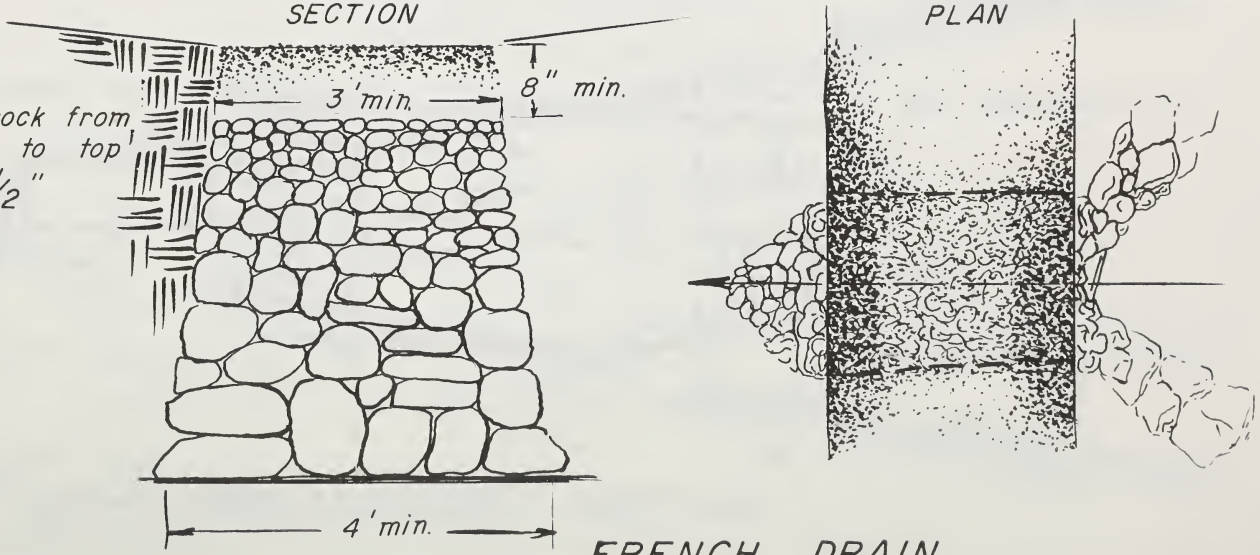
TYPICAL ROCK CULVERT



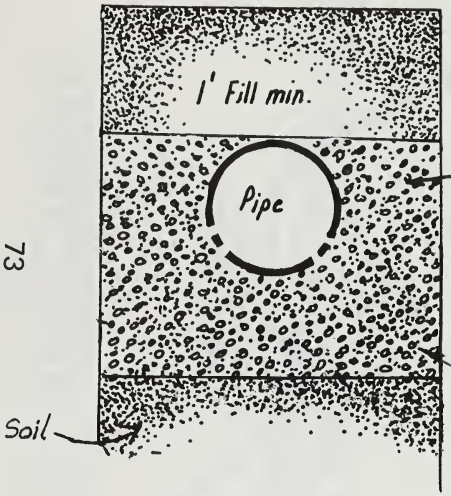
EMBANKMENT SECTION



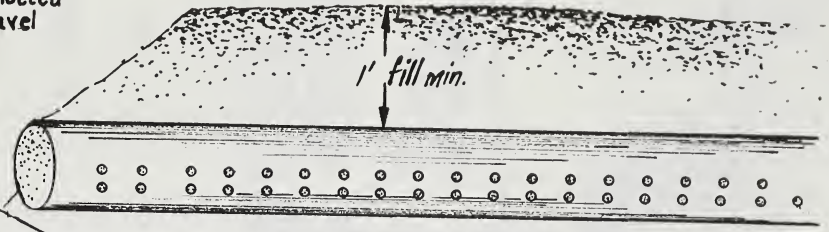
SIDEHILL SECTION



FRENCH DRAIN

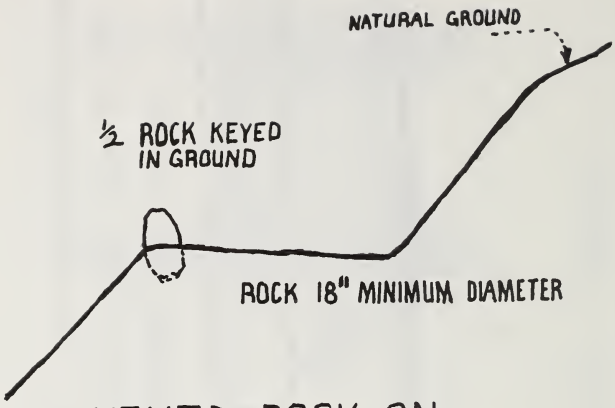


End View

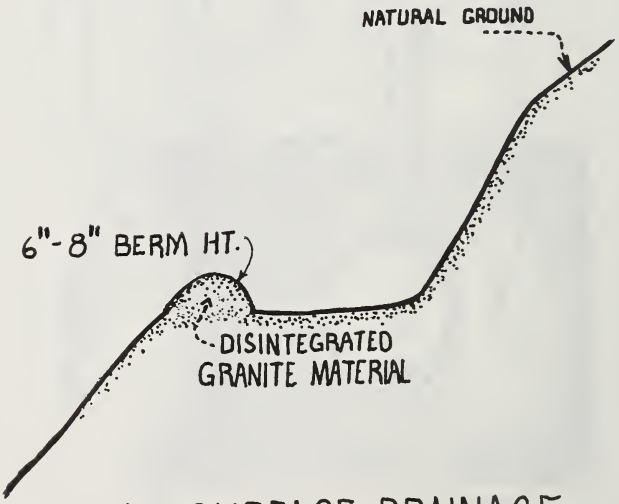


Perforated Pipe (10" min.)

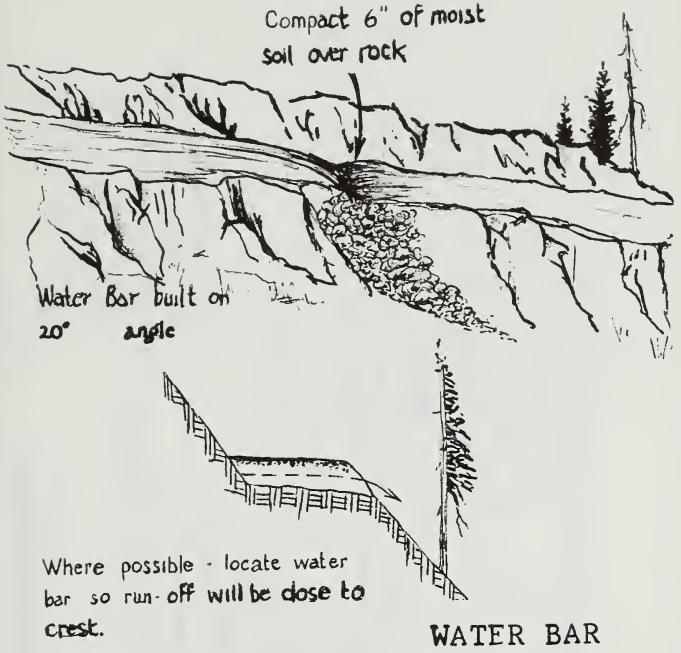
Select backfill, 1½" min. clean pourous gravel or rock extending 1' min. adjacent to perforated pipe.



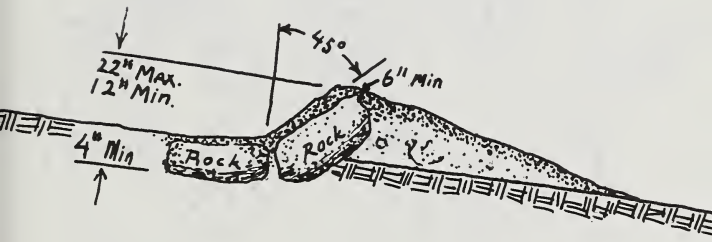
KEYED ROCK ON SHOULDER EDGE



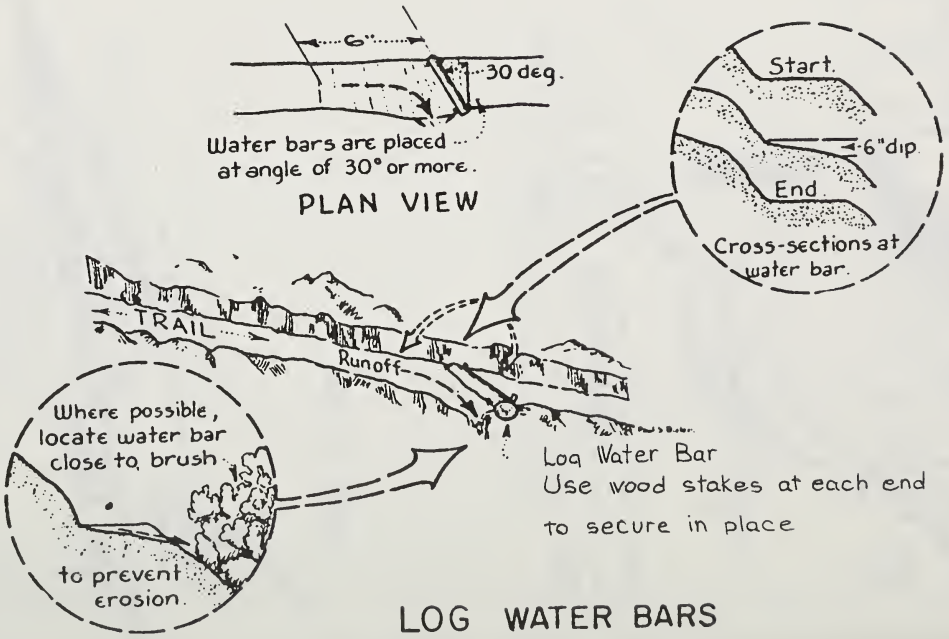
BERM - SURFACE DRAINAGE



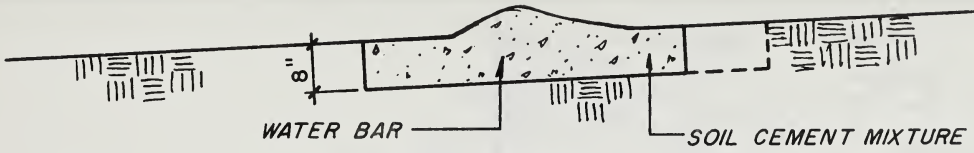
WATER BAR



ROCK WATER BAR



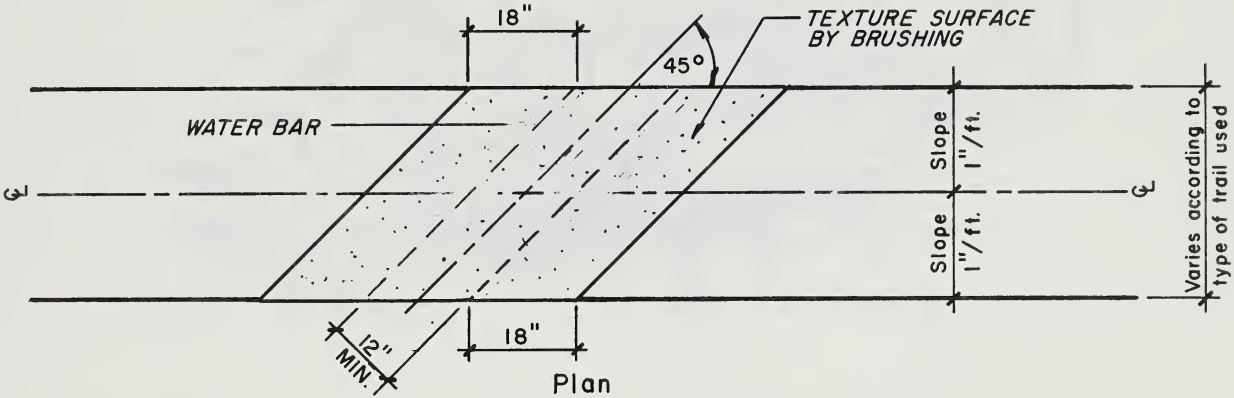
LOG WATER BARS



Longitudinal section on center line

NOTE:

Use water bar in areas where trail surface is loose gravel or a soil cement mixture. DO NOT USE if center line grade exceeds 5%.



Plan

77

DRAINAGE DIP DIMENSION
DRAINAGE DIP
Prevailing Grade
10' Min.
5'
Min.
10%
Trail Tread d
outslope-2%

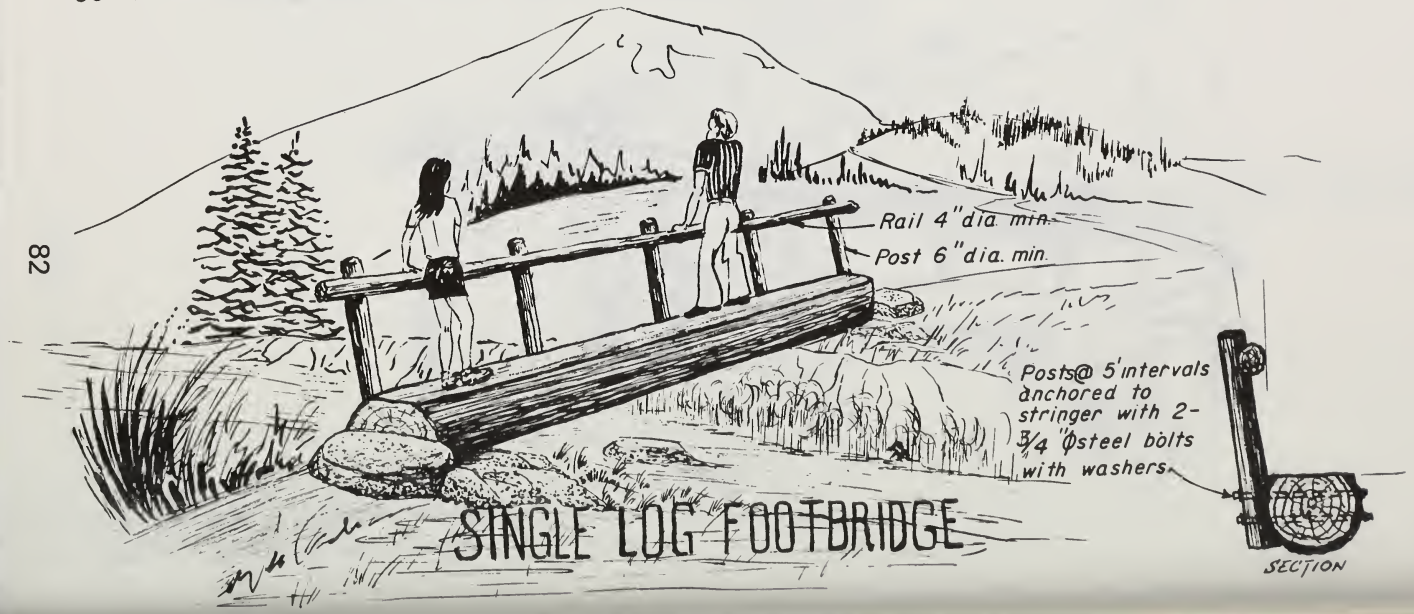
SMALL STREAM OR DRAINAGE
DIP CROSSING

WATER BAR SPACING GUIDE

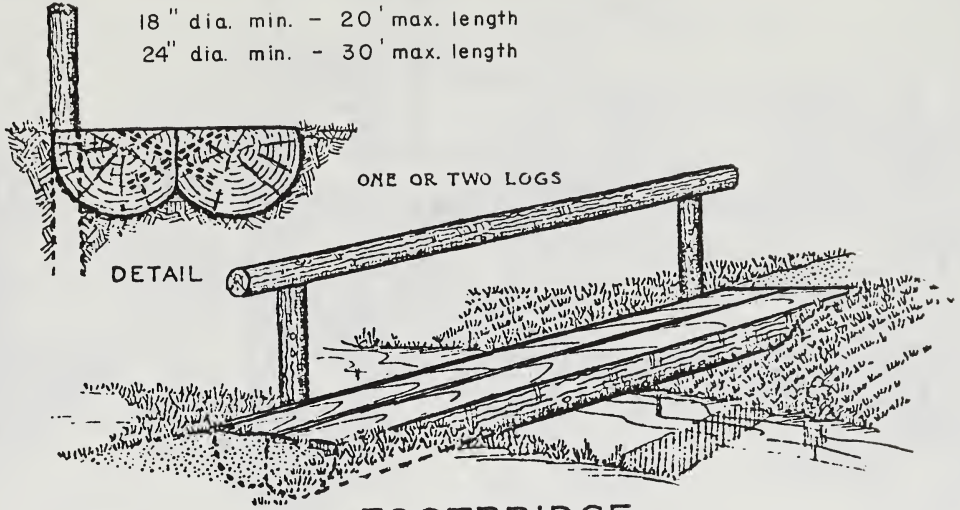
Trail Grade %	Max. Spacing - Ft.
6	600
7	500
8	400
10	300
12	200
15	100

Allow for stability of soil type (characteristics that influence erosion), precipitation, and height and steepness of slope above trail in deciding on spacing of water bars.

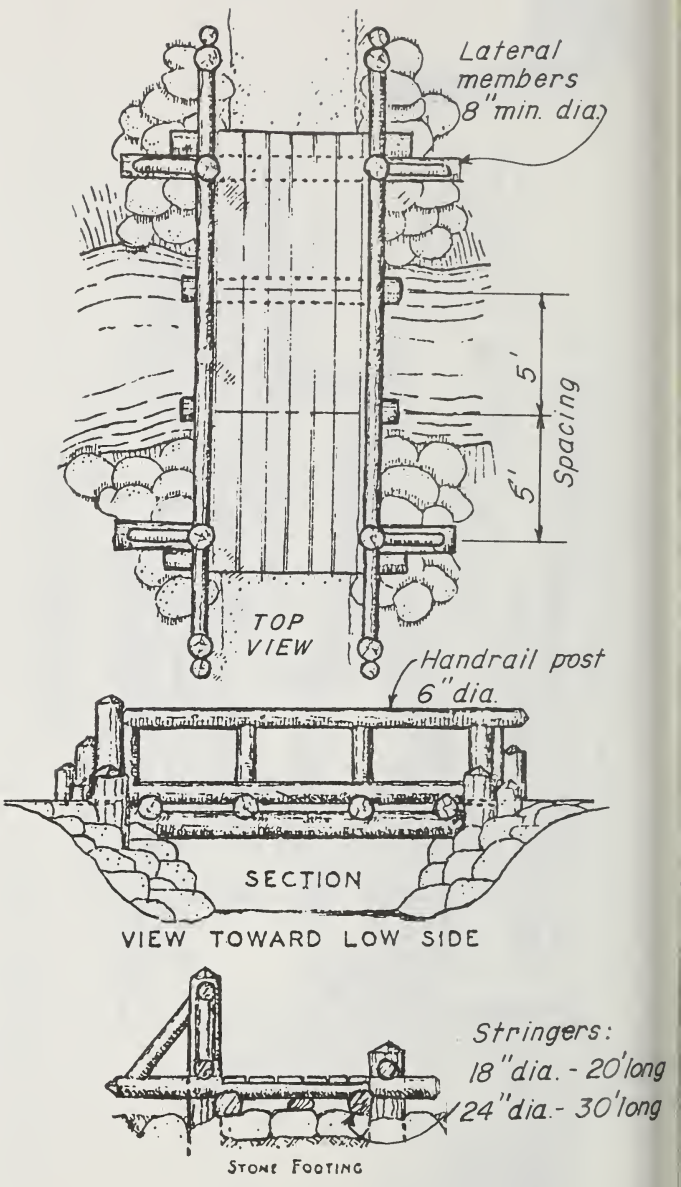
MULTIPLE LOG FOOT BRIDGE



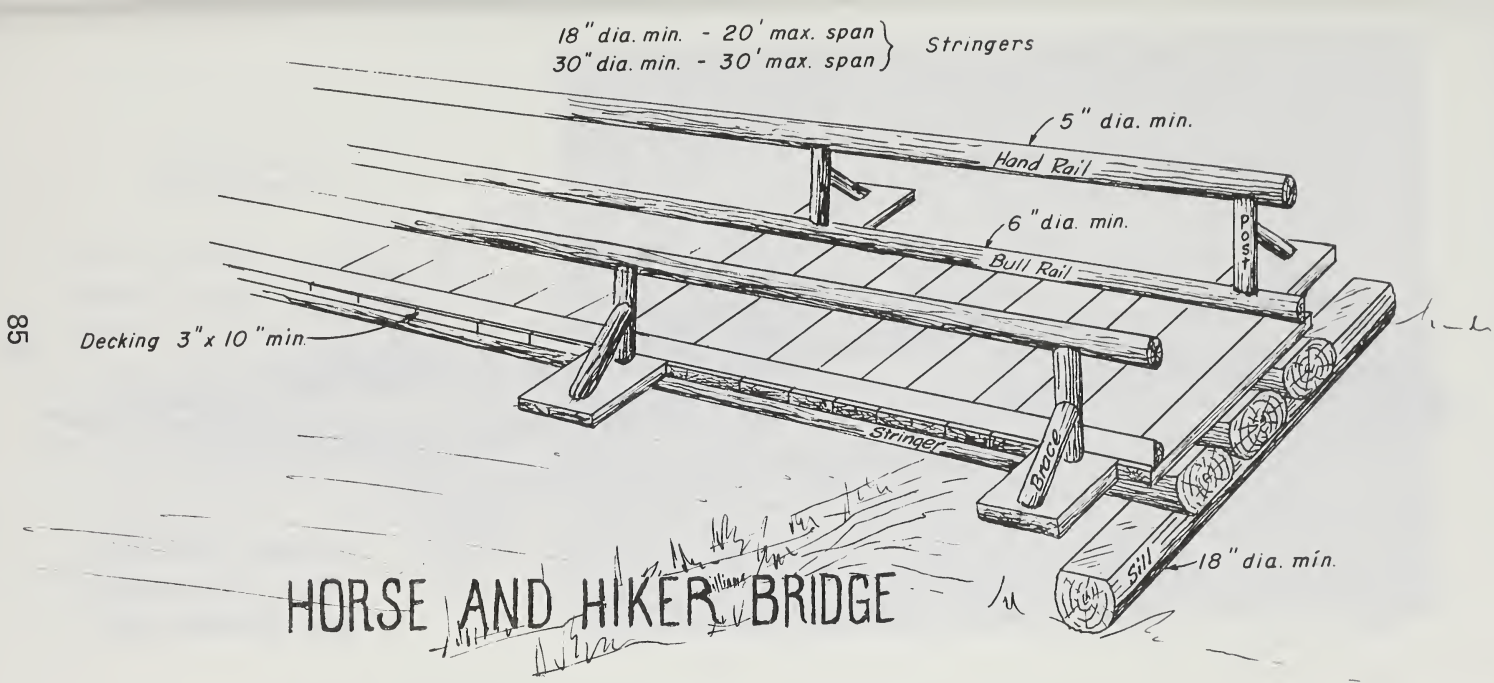
SINGLE LOG FOOTBRIDGE


18" dia. min. - 20' max. length
24" dia. min. - 30' max. length
ONE OR TWO LOGS
DETAIL

FOOTBRIDGE

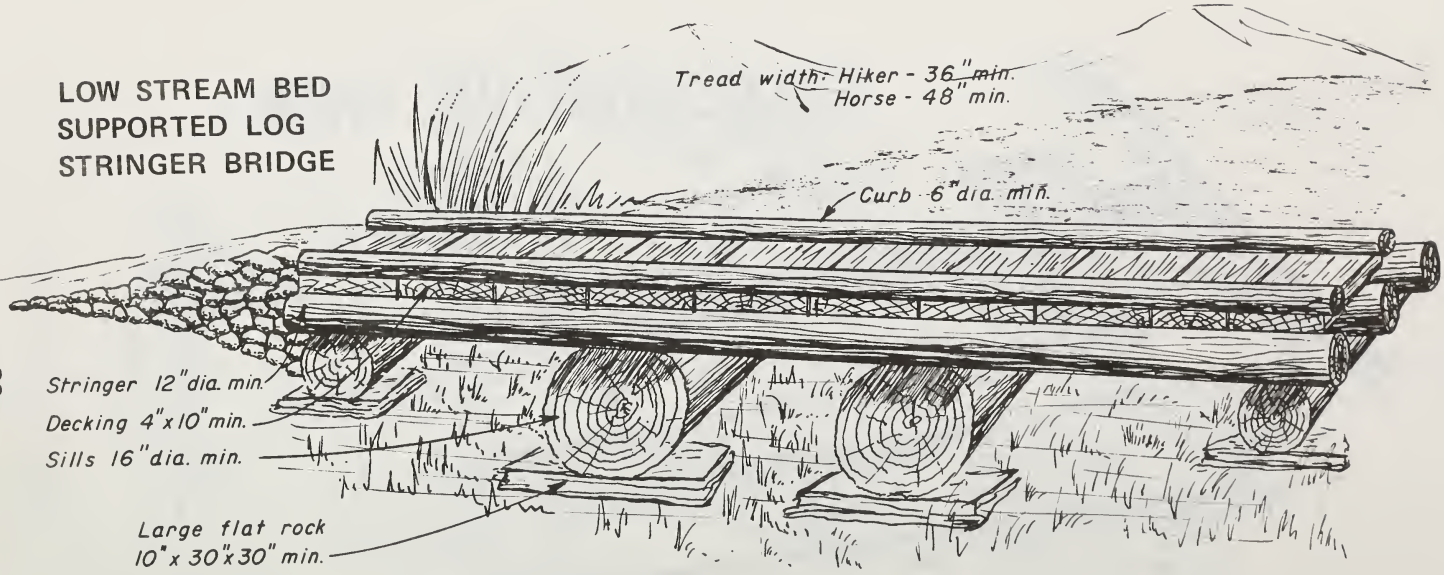

Lateral members 8" min. dia.
5'
Spacing
5'
TOP VIEW
Handrail post 6" dia.
SECTION
VIEW TOWARD LOW SIDE
Stringers:
18" dia. - 20' long
24" dia. - 30' long
Stone Footing

FOOTBRIDGE



HORSE AND HIKER BRIDGE

LOW STREAM BED SUPPORTED LOG STRINGER BRIDGE



ALUMINUM BRIDGE

Sectionalized for transportation by helicopter or horseback

Permanent type bridge for hiker and horse.

Step riser not to exceede 8".
Step rock to be min. 5" thick.
Provide flat landing of 4'-6"
when step vertical rise
exceeds 50"

TRAIL STEPS

RIVER FORD

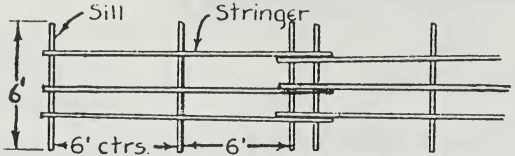
Provide when trail traffic is light and bridge cost are out of proportion to actual use.

FORD

BUILT - UP
PUNCHEON

BUILT - UP
PUNCHEON

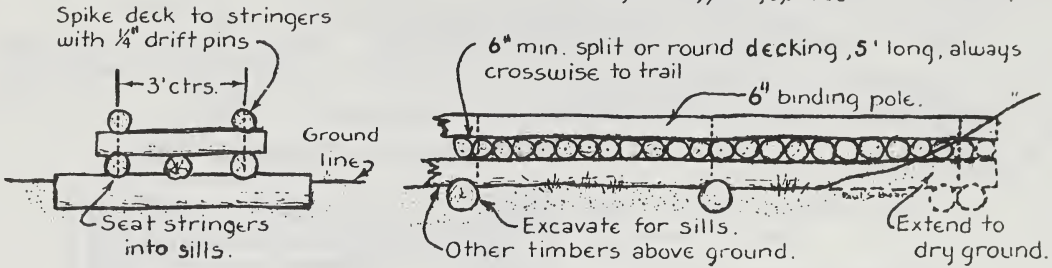
BUILT - UP
PUNCHEON



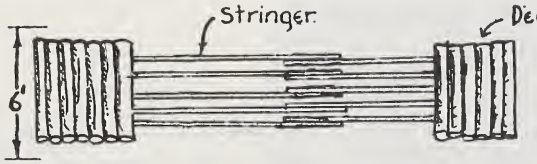
Lay stringer ends side by side at joints - on double mud sills Stringers and sills at least 10" in diameter. Peel all logs.

SILL & STRINGER SECTION

Use most durable species available: cedar, fir, larch, pine, spruce - in that order.



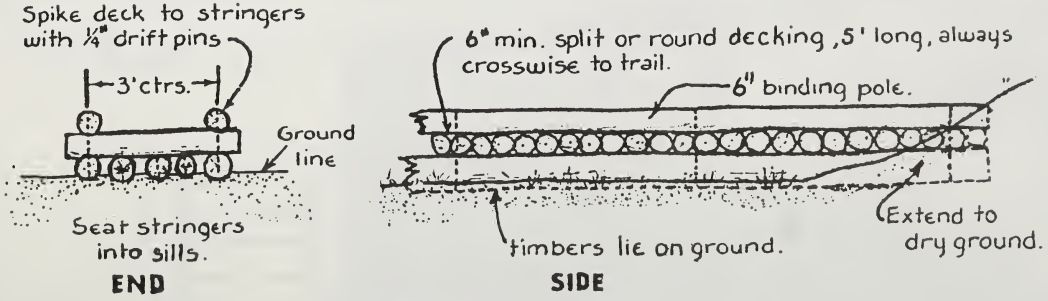
CORDUROY CONSTRUCTION



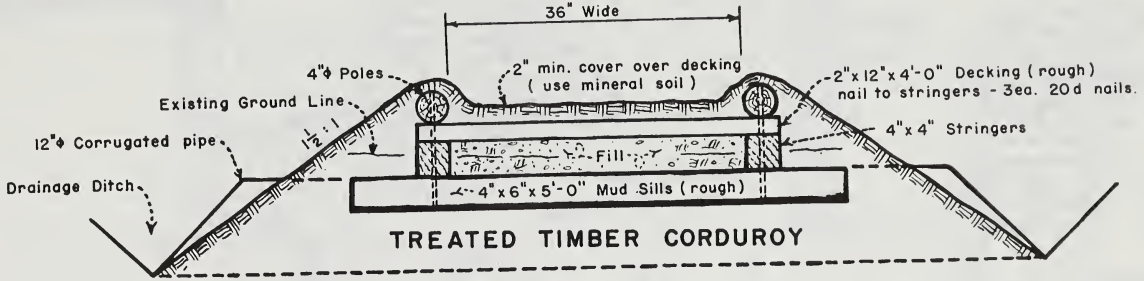
Lay stringer ends side by side at joints - Stringers at least 10" in diameter. Peel all logs.

STRINGER SECTION

Use most durable species available: cedar, fir, larch, pine, spruce - in that order.

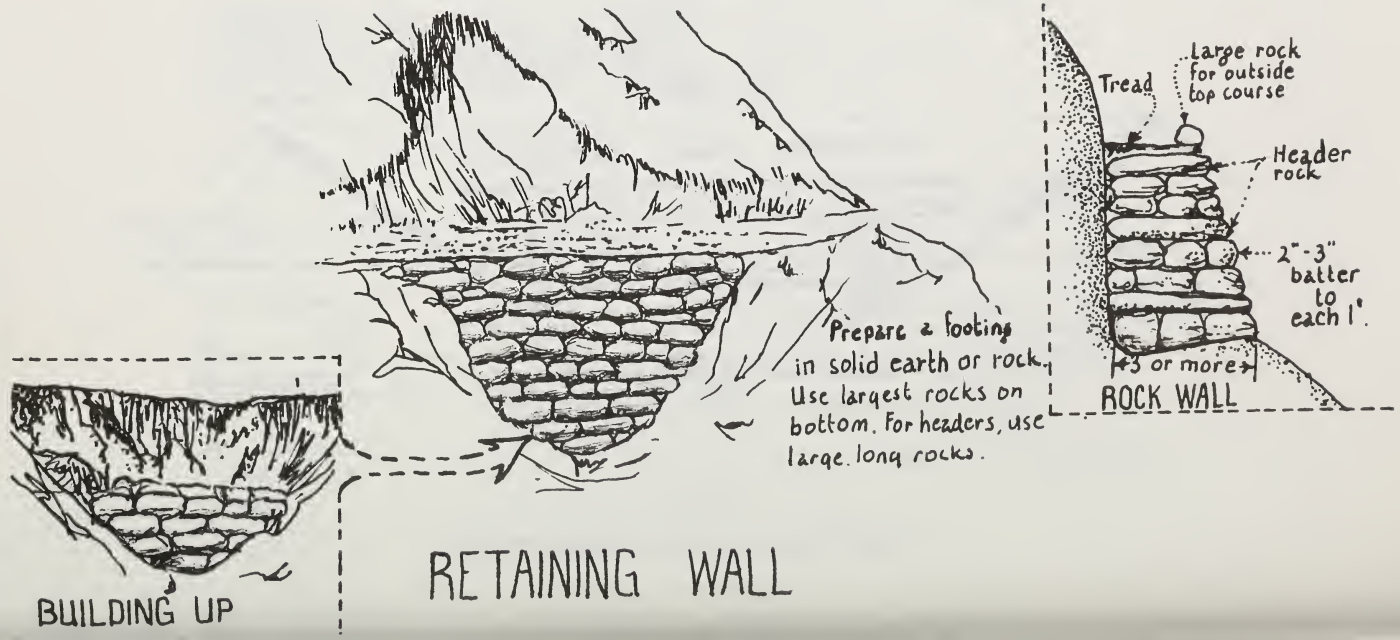


CORDUROY CONSTRUCTION

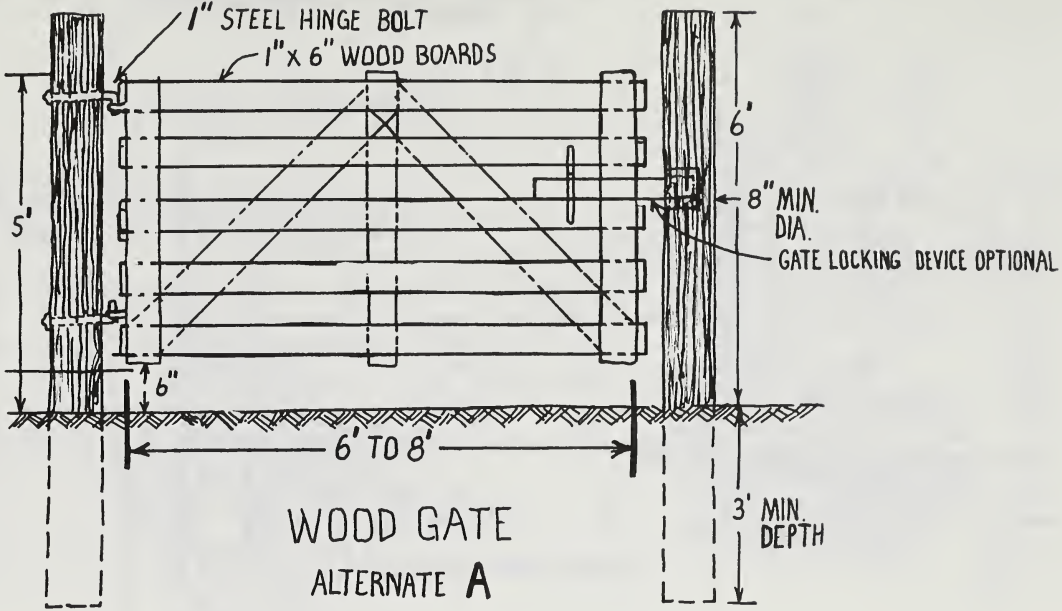


TREATED TIMBER CORDUROY

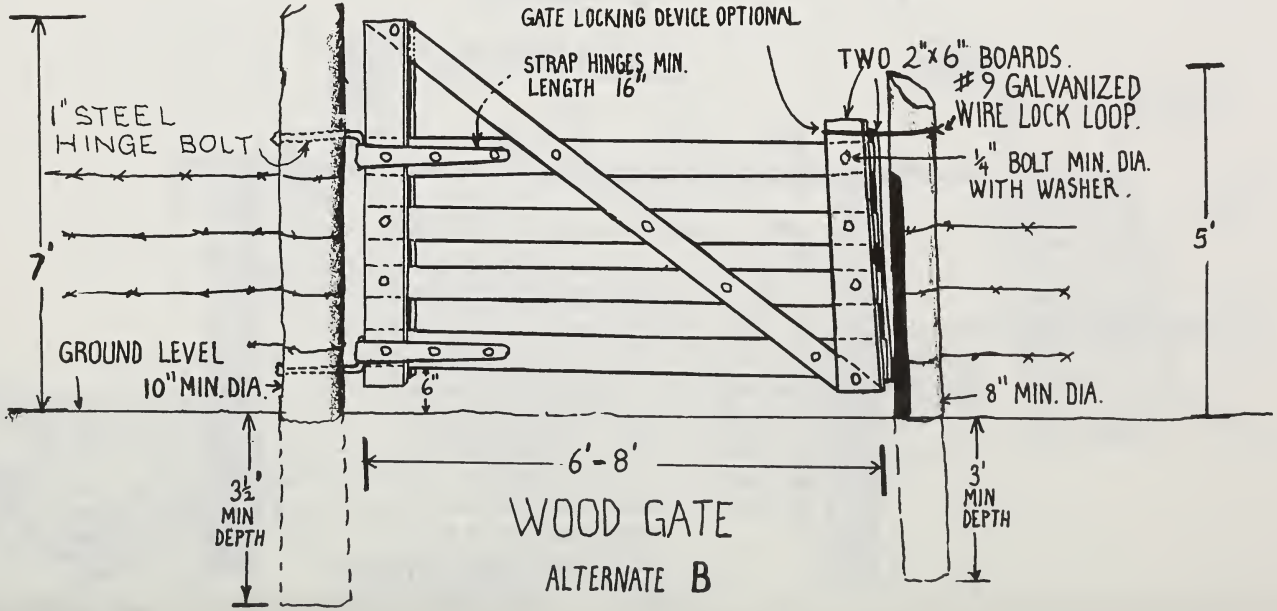
SECTION

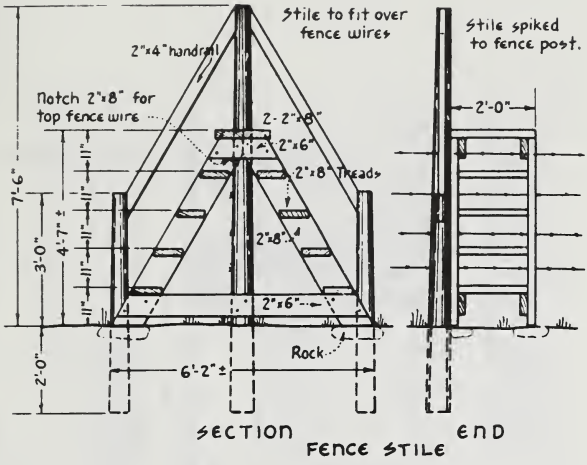


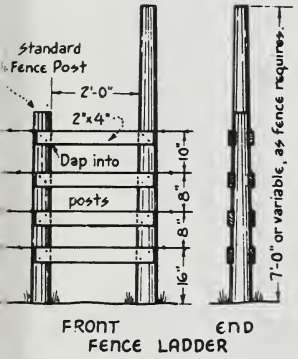
RETAINING WALL

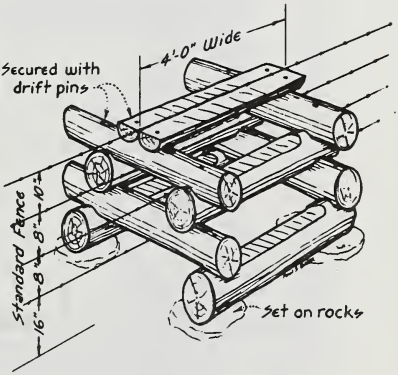


WOOD GATE
ALTERNATE **A**

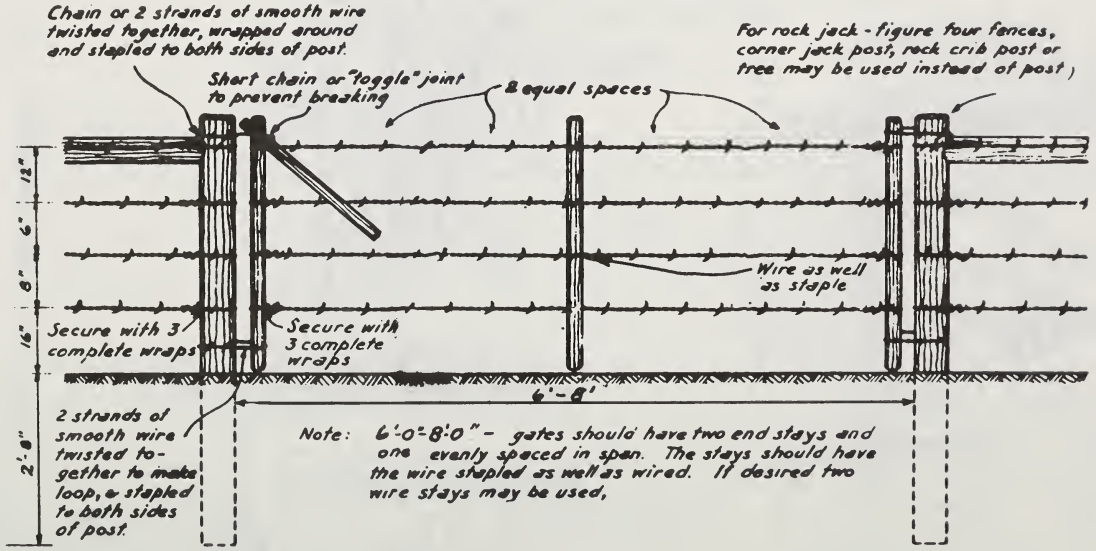

GATE LOCKING DEVICE OPTIONAL
STRAP HINGES MIN. LENGTH 16"
TWO 2"x6" BOARDS.
#9 GALVANIZED WIRE LOCK LOOP.
1" STEEL HINGE BOLT
¼" BOLT MIN. DIA. WITH WASHER.
7'
5'
GROUND LEVEL
10" MIN. DIA.
6"
8" MIN. DIA.
6'-8'
3½' MIN DEPTH
3' MIN DEPTH
WOOD GATE
ALTERNATE B



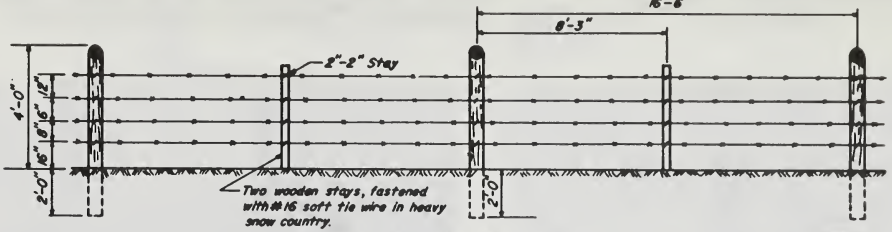




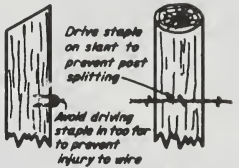
STILES & FENCE LADDER


Chain or 2 strands of smooth wire twisted together, wrapped around and stapled to both sides of post.
Short chain or "toggle" joint to prevent breaking
8 equal spaces
For rock jack - figure four fences, corner jack post, rock crib post or tree may be used instead of post.)
Wire as well as staple
Secure with 3 complete wraps
Secure with 3 complete wraps
6'-8'
2 strands of smooth wire twisted together to make loop, & stapled to both sides of post.
12"
6"
8"
16"
2'-8"
Note: 6'-0"-8'-0" - gates should have two end stays and one evenly spaced in span. The stays should have the wire stapled as well as wired. If desired two wire stays may be used,

WIRE GATE



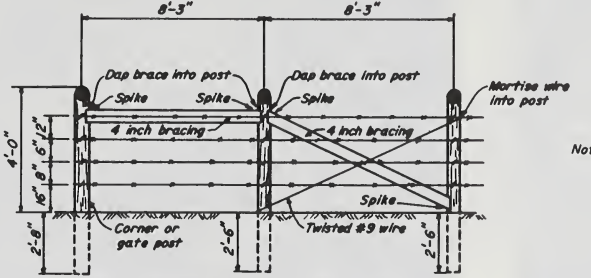
SECTION OF LINE FENCE



CONSTRUCTION HINTS

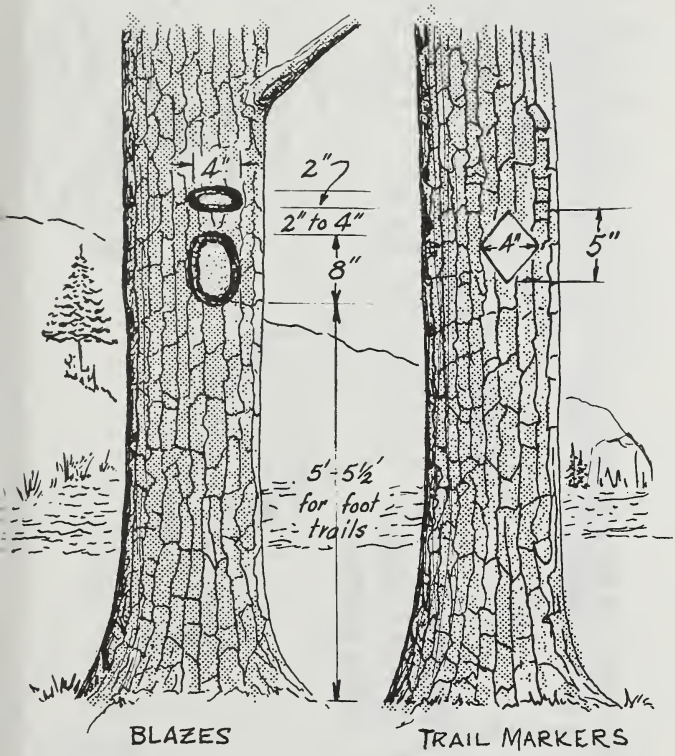
Note - For 3 wire fence use spacing of 16", 12", 12" for total height of 40".

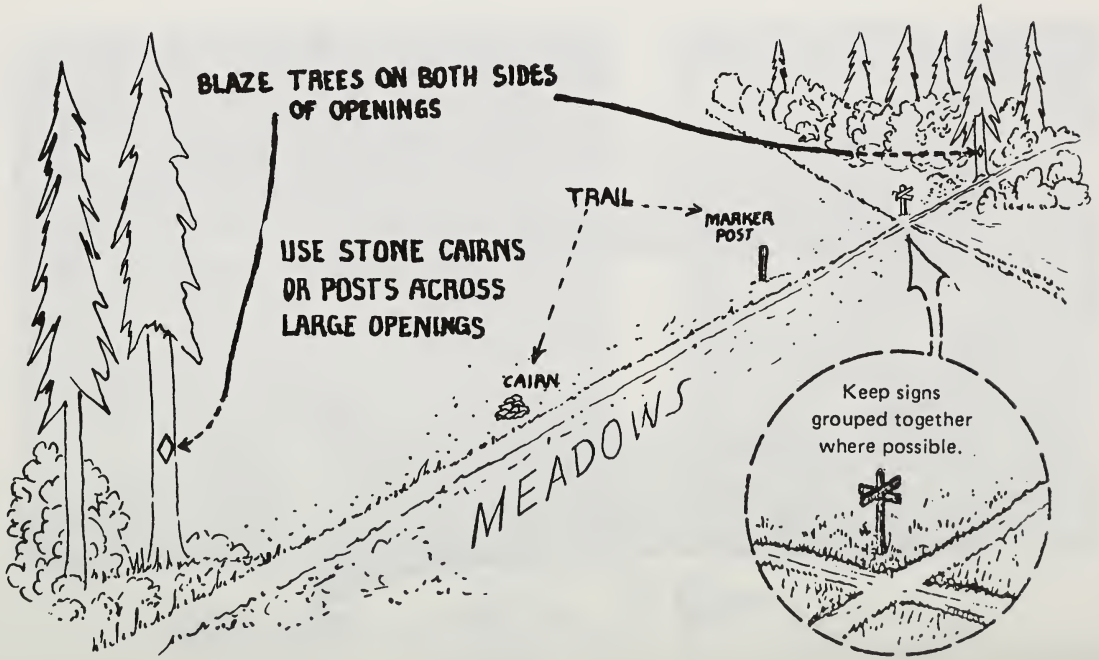
STANDARD BARBED-WIRE FENCE



STANDARD BRACING FOR CORNERS AND GATES

STANDARD WOOD SIGN INSTALLATION


4"
2"
2" to 4"
8"
5' - 5½'
for foot
trails
4"
5"
BLAZES
TRAIL MARKERS


BLAZE TREES ON BOTH SIDES OF OPENINGS
TRAIL
MARKER POST
USE STONE CAIRNS OR POSTS ACROSS LARGE OPENINGS
CAIRN
MEADOWS
Keep signs grouped together where possible.

4'
2'
TRAIL MARKER POST
CAIRN

Hand Tools

HANDTOOLS

Handtools and equipment most commonly used for trail construction and maintenance are:

Abney Hand Level	Graduated in degrees and percent, with carrying case.
Axes (with protector sheaths)	Double bit, Western style, 3-1/2 lb. or 4-1/2 lb. head with 34" or 36" wood handle.
	Single bit, 2-1/2 lb. or 3-1/2 lb. head.
Bars	Digging — 1-1/8" x 6' Prying — 1-1/2" x 6', thickened, broad chisel end.
Blasting Machine	Galvanometer and related equipment. Blasting equipment and work will be provided and performed by a certified Forest Service blaster.
Brush Cutter, Hand	Heavy duty type.
Brush Cutter, Powered	10"-11" circle saw.
Brush Hook	Strap eye, 11" blade, wood handle.
Canteen, Water	4-quart plastic, with carrying strap and chained screw cap. (Forest Service Spec. 5100-0083.)
File	Flat mill bastard, 8" or 10" length, with wood handle and leather or rubber belting protection disk.
Flagging	Vinyl plastic — orange, red, yellow, etc., 1-3/16" width.
Hammers	Carpenter, claw; sledge, 8-10-12 lb. head, wood handle.

Hard Hats	Meet ANSI and OSHA standards, with elastic chin strap.
Marking Crayon Holder	Use with carbon black, lumber marking crayon.
McLeod Tool	Used as grubbing and raking tool.
Measuring Wheel	Dual counter, heavy duty.
Pack	Sack, canvas, waterproof, olive drab, 6-1/2" x 14" x 17". (Forest Service Spec. 5100-214a.)
Picks	Contractors, point and chisel ends, wood handle. Mattock, point and broad ends, wood handle.
Pliers	Fence, heavy duty, 10" length, with prong and hammer heads. Linemen's side cutter, 8", plain handle.
Pulaski Tool	4-1/4 lb. head, wood handle, used for grubbing.
Saws	1 man cross cut; 2 man cross cut; Pruning saw, hand; Pruning saw, pole, 8" length.
Sharpening Stones	Axes, 5/8" x 3" diameter minimum, round shape, two-grit stone.
Shovel	Round point, "0" or No. 1, long wood handle.
Tape	Engineers, 100' metallic with case.
Wedges	Wood — used to secure han-

dles on axe, pulaski, picks, mattocks.
Steel — for use in felling and splitting.

NOTE:

Tools can be dangerous. Handle them carefully. To be effective, they must be kept in good working condition. Use the proper tool for a specific job.

GLOSSARY

Abutment (Bridge) — The foundation at either extreme end of a bridge that supports the sill, stringers, and deck structure.

Backslope — The cut bank formed by the excavation extending upward from the tread.

Base — The primary excavated bed of a trail upon which the tread or finished surface lies.

Berm — The ridge of dirt or rocks placed on the outside edge of the trail base.

Blaze — A standard trail mark cut into the bark of a tree with an axe to designate the trail location.

Classification — The general designation indicating the standard of a trail.

Maintenance Activity — A specific type of work that is carried out to keep a trail in its originally constructed serviceable standard.

Maintenance Level — The degree to which each maintenance activity must be performed to satisfy the purpose and the safe use of the trail.

Cairn — A constructed mound of rock located adjacent to a trail. Used in open alpine areas.

Corduroy-Puncheon — A log structure laid on the ground for the purpose of crossing swampy ground. Usually consists of stringers, decking, and often a soil or loose gravel tread on top of decking.

Deck or **Flooring**	That part of a structure which provides direct support for trail traffic.
Dip	A reverse in the grade of the trail accompanied by an angling outslope which will divert water off the trail.
Drainage, cross	Running water in swamps, springs, creeks, drainages, or draws which the trail must cross.
Drainage, surface	Rain or snow runoff from the surface of the tread.
Ford	A natural stream crossing improved sufficiently for use by saddle or pack animals.
Grade, maximum	The steepest grade permitted on any part of the trail.
Header	A long, uniform stone laid with its end toward the face of a retaining wall or crib used intermittently to structurally tie-in the other rocks laid in the wall.
Outsloping	A method of base grading which leaves the outside edge of the trail lower than the inside.
Pier (Bridge)	Intermediate bridge supports located between two adjacent bridge spans.
Run Plank	Plank laid lengthwise on top of bridge decking used as the tread surface.
Sideslope	The natural slope of the ground measured at right angles to the centerline of the trail.

Sill	The crosswise member at the top of a pier or abutment that supports the stringers.
Specifications	The standard of workmanship and type of materials for all component parts of the trail base, trail tread, clearing, grade, bridge, culvert, puncheon, etc.
Stakes, grade & slope	Stakes set by the locator to establish the elevation and cross section of the completed tread.
Stakes, line	Stakes set by the locator to establish the centerline of the trail.
Station	One hundred feet measured along the centerline of the trail.
Stringer	The lengthwise member of a structure that supports the deck.
Switchback	A sharp curve in the trail, used on hillsides to reverse the direction of travel and to gain elevation.
Trailblazer	A diamond-shaped, gray-white marker 4 inches by 5 inches in size used to identify the trail location and located on tree or post adjacent to the trail. This marker will not be used within Wilderness or Special Areas.
Tread	The surface portion of the trail upon which the traffic moves excluding backslope, ditch, and shoulder.

Turnout	A place where the trail is widened to permit trail traffic traveling in opposite directions to pass.
Water Bar	A device for turning water off the trail, usually made of logs, stones, soil cement, or by contouring the native material within the trail prism.

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